

Digital Occlusal Analysis an Alternative Occlusal Indicator-A Review

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Abstract

Background: All disciplines of dentistry require that clinicians assess the articulation of the teeth/prosthesis with respect to simultaneous contacts, bite force and timing.

Aim: This article intends to describe the advantages and limitations of the data acquired when using a digital occlusal analysis as a dynamic occlusal indicator.

Methodology: A search of the literature was completed (Medline, PubMed) using the keywords occlusion, occlusal registration, computerized occlusal analysis and T-Scan for dental.

Results: According to the evidence available, the digital occlusal analysis system is the only occlusal indicator that demonstrates the ability to provide quantifiable force and time variance in a real-time window from the initial tooth contact into maximum intercuspation.

Conclusion: The reported advantages to accurately indicate occlusal contacts make the digital occlusal analysis system a better occlusal indicator when compared with other non-digital convention indicator materials available.

Keywords: Occlusion, Occlusal registration, Digital occlusal analysis, T-Scan, Accura scan

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INTRODUCTION

Dental practitioners to get satisfactory clinical results, they must have knowledge of occlusion. Fortunately, physicians are becoming more interested in the biomechanical aspects of occlusion(1). Based on the glossary of Prosthodontics terms (2005), Dental occlusion is 'the static relationship between the incising or occlusal surfaces of the maxillary or mandibular teeth or tooth analogues. The occlusion should be balanced and as stress free as possible'. It is important to maintain equilibrium and minimise tension in the occlusion. However, the clinical concept of occlusion also takes into account the static morphological interactions between teeth and the mandibular movement(2,3). The entire masticatory system, including the teeth, periodontal tissues, neuromuscular system, temporomandibular joint, and cranial bones, are all involved in dynamic morpho-functional interactions.

An occlusal contact may be defined by its shape, size and position regardless of whether it actually makes occlusal or near occlusal contact with the opposing teeth. Occlusal contact refers to the contact between teeth when the inter-occlusal distance between the occluding areas is less than 50 mm; whereas near occlusal contacts occur when the distance is between 50 and 350 mm(4). For proper functioning, occlusal contacts must be synchronized with the stomatognathic system.

Classification Of Tooth-Contact Patterns

The tooth contact patterns were classified into four groups as follows:

1. Cuspid protected occlusion: contact of canines on the working side.
2. Group function occlusion: contact of canines, premolars, and/or molars, or contacts of premolars and molars on the working side only.
3. Full balanced occlusion: tooth contact patterns with group function or cuspid protected occlusion on the working side plus multiple tooth contacts of posterior teeth on the nonworking side.
4. Others: occlusal patterns other than those described. Contact of incisor teeth, if any, were included in this classification.

When considering the dynamic interactions between maxillary and mandibular teeth, the "mutually protected" occlusal scheme has been regarded as the ideal occlusal connection. The posterior teeth make simultaneous contact in this occlusal relationship, and the contacts are evenly spaced apart in a central occlusion (or intercuspal position). The canines disclude the posterior teeth during lateral excursion movements, whereas the anterior teeth disclude the posterior teeth during protrusion. (5)

However, measuring dental occlusal forces often requires complex yet inaccurate interpretation based on non-digital occlusal indicators used in clinical practice, along with patient's feedback. Therefore, assessment of the occlusion is crucial to remedying the various occlusal issues mentioned previously. This article reviews the advantages and limitations of a Digital occlusal indicator whose use is indicated in clinical practice to analyze and remedy the discrepancies during occlusal balancing procedures.

Digital Occlusal Analysis

T-Scan

The T-SCAN system for computer occlusal analysis was developed by Maness in 1987. It yields measurements in real-time of occlusal forces recorded using the T-SCAN intraoral sensor(6). In 1992, Lyons et al found in a clinical study evaluating the T-SCAN system for measurement of occlusal forces, that the system was unable to measure them accurately although it can still serve as a useful clinical tool (7). In Bulgaria, several studies were conducted on the occlusal-articulation relation in intact dentition during articulation with T-SCAN II elucidating the relationship between occlusal load and periodontal stress. The first generation (G1) sensor developed in 1987 has undergone many changes in its design and improvement of its registration capacity based on many clinical studies. The last generation sensor developed by the same company is the high definition sensor which is far more sensitive and thinner(105 μ) than the previous sensors (8). Two sizes of this sensor are now available on the market: a small size accommodating dental arches up to 58 mm wide, and a large one that can accommodate up to a 66-mm-wide dental arch (9).

The original design of the T-SCAN system has been repeatedly modified and improved both in the software and hardware until the present-day version of the system - T-Scan III. The software uses a graphical interface. The program processes the data and shows them in full-colour 3D or 2D graphics. In the 2D graphics, the generated occlusal contacts are visualized as contours or cellular images on the dental arch. There is an optional feature that allows the left and right sides to be shown in different color codes, green on the left and red on the right, with the respective occlusal forces displayed below. The dentition can also be divided into anterior and posterior halves giving as a result 4 segments to analyze. In the 3D graphics, the registered contacts are visualized as columns of different colors and height quantifying the intensity of the forces generated on occlusion. The magnitude of the occlusal load is color-coded the maximum is shown in pink and the minimum force in blue (10).

T-SCAN III analyses the order of the occlusal contacts while simultaneously measuring the force percentage changes of those same contacts, from the moment the teeth first begin making occlusal contact through to centric intercuspation. It shows the abnormal forces leading to trauma or pain in every tooth in the dental arch. This helps to balance the forces on both sides of the dentition. Because of this many authors consider the T-SCAN III system to be a highly accurate technique to study and analyze the occlusal and articulation relations. They also state that the system has certain advantages in terms of accuracy, reproducibility, and visualisation of the dental arches (11-13).

This 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 (14). 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. A major advantage of the system is that it is a useful

clinical method that eliminates a biased, subjective evaluation of the occlusal and articulating relations on the part of an operator (15). Many authors have also supported the use of T scans showing great promise to determine occlusion both pre and post-operatively in cases requiring orthodontics and orthognathic surgery (16-18).

Accura scan

In 2017, the Accura (Dmetec Co., Bucheon, Korea) system was introduced with claimed lower cost and easier maneuverability is a new computerized occlusal analysis system that shows the change of occlusal force in real time, similar to the T-scan. According to the manufacturer's information, the Accura film sensor has 1172 to 1390 sensing units. The devices have 256 levels for recording masticatory force it can measure the absolute occlusal force. The sensor film is made of polyimide and is 160- μ m thick. The device is connected to the computer through Wireless Fidelity (Wi-Fi) for data transfer.. The technical specifications regarding the film sensor is similar to T-Scan (19).

Advantages of the Digital occlusal analysis

The conventional static occlusal indicators such as articulating paper and waxes only reveal the contact size and location, whereas the T-Scan has an additional ability of quantifying occlusal contact timings and forces(20).

The computerized system presents a superior alternative to conventional occlusal registration methods due to its ability to record dynamic tooth contact relationships as force and timing data. Additionally, the computerized system can display the relative occlusal force variance from the first point of contact to MIP, in real time (21). In contrast, a study on articulating paper marks made at various occlusal force loads showed that more than 80% of the marks have no correlation between the mark size and the load applied(22). This establishes the inadequacy of articulating paper marks in describing the occlusal load. The study mentioned earlier on paper mark inaccuracy demonstrated that the largest mark corresponds to the highest force load only 38% of the time and that the dentists would be subjected to choosing and modifying the wrong tooth at least 62% of the time(21).

The data available during T-Scan recordings improves the precision and treatment outcome of the occlusal adjustment procedure. Occlusal analysis technology adds dynamic and quantifiable value to the many non-digital, conventional occlusal indicators; thereby, clinicians no longer have to rely completely on subjective interpretation using static indicators. The new feature of synchronization of the computerized occlusal system data with electromyography is also able to demonstrate the abnormal dysfunction of the musculature via the center of force patterns and the disclusion timing. Therefore, the T-Scan is able to provide precise, definitive diagnosis of the occlusal force balance and masticatory muscular function for the clinician, and it is a comprehensive educational tool for the patient undergoing occlusal balancing procedures(23).

Limitations of the Digital occlusal analysis

While T-Scan occlusal analysis technology provides quantifiable time and force variance from the first point of contact to MIP as the subject bites onto the occlusal sensor, it does not have the capacity to measure absolute bite force. The sensor thickness is 100 μ m (0.1 mm) that compresses down to 60 μ m under bite force, which may arguably interfere with intercuspation. The company claims that the highly compressible capacity of the sensor also provides bilateral interference during mandibular movement, providing improved occlusal force data when compared with unilateral interference of articulation paper strips that are frequently used to determine excessive contact areas on one side of the arch only.

The challenge many clinicians face is the increased chair-time during computerized occlusal adjustment procedures, since a good T-Scan recording requires a number of skills. The significant learning curve involves getting familiar with appropriate sensitivity settings, orally guiding the patient through the needed mandibular movements, observing the screen to follow the center of force trajectory, and recognizing what is taking place within the recording. While clinicians may feel that operating the device may be too time consuming, the increased chair-time allows them to complete their objective accurately, without having to make multiple adjustments common among conventional practices. However, evidence must be interpreted with caution, since most studies are case series reports (24). Therefore, further studies, such as clinical trials, are recommended to confirm the computerized technology superiority over the conventional occlusal indicators.

Conclusion

The only occlusal indicator that exhibits the ability to offer quantitative force and temporal variance in a real-time window from

the initial tooth contact into MIP, according to the current evidence, is the Digital occlusal analysis system. When compared to other non-digital traditional indicator materials available, this system is a better occlusal indicator due to the observed benefits to reliably detect occlusal contacts. If done correctly, T-Scan occlusal analysis recordings can give insight into occlusion and related discrepancies, enhancing doctor-patient communication, reducing issues from restorative follow-up visits or occlusal imbalance, and improving treatment outcomes. In order to analyse both static and dynamic occlusal contacts, it can be helpful to combine technology and conventional technique.

Conflict of Interest

None

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