



The Importance of T-Scan III Digital Electronic System in Fixed Restorations Occlusal Analysis – A Review

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Abstract

BACKGROUND: Occlusion is one of the most important aspects of dentistry. Dental occlusion differs among individuals. Subsequently, realizing the correct physiological occlusion is essential for the complex functioning of the stomatognathic system during the mouth prosthodontics rehabilitation.

AIM: The purpose of this review paper is to provide an overview of the T-Scan system over its utility in fixed restorations occlusal analysis.

MATERIALS AND METHODS: An electronic search was performed through PubMed, MEDLINE, Web of Science, and Google Scholar. The inclusion criteria for selection were articles reporting the occlusion analysis using articulating paper as a conventional method, and occlusion analysis using T-Scan III digital electronic system to detect contact points between the mandibular and maxillary teeth.

RESULTS: The electronic search identified 70 titles. Authors ended up with eight studies which have been divided into two tables. The first table is described four studies which present a comparison between the T-Scan III electronic system and articulating paper. The second table is described 4 studies which present occlusal analysis using the T-Scan III electronic system.

CONCLUSION: Based on the published literature, this review has highlighted some advantages of the T-Scan electronic system compared to articulating paper. The studies showed that the T-Scan computerized occlusal analysis which can provide quantifiable occlusal force and timing data that will make it possible to better protect brittle dental ceramic, and most importantly, to improve the quality of patient's lives with improved bite comfort and chewing function.

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Introduction

Occlusion is one of the most important aspects of dentistry. From a dental perspective, occlusion means purely the contact between maxillary and mandibular teeth when the mouth is closed. While patients may not think about their bite during everyday activities when misaligned, it can cause to experience tooth wear and tear, abnormal grinding, migraine-like headaches, clicking of the jaw, and symptoms of the neck and shoulder region [1].

Dental occlusion differs among individuals. The common occlusion and articulation relationships among the jaws ensure balanced spreading of the generated forces throughout mastication [2]. Subsequently, realizing the correct physiological occlusion is essential for the complex functioning of the stomatognathic system during the mouth prosthodontics rehabilitation [3]. Humans, when biting, exert hundreds of pounds of force per square inch, and it only makes sense that equal contacts during occlusion will allow for the forces to be shared among all teeth. When one of the teeth interferes

with equal contact, it can lead to severe damage to these teeth, as they will absorb excessive forces [2], [3].

The maxillary first molars, which are considered the “key to occlusion,” were first described by angle, as they lodge a normal position more frequently than any other tooth, and their loss causes an unbalanced occlusion, a case that occurs often even at a young age [4], [5].

During the mouth prosthodontics rehabilitation, occlusal discrepancies are one of the most deleterious functional problems perceived after the treatment [6]. Therefore, the importance of using a fixed restoration is to provide a physiologically and mechanically sound occlusion.

In dentistry, there are a variety of occlusal analyzers, used to record the occlusal-articulation relation. Those occlusal analyzers can be generally divided as quantitative and qualitative gauges. The quantitative gauges are T-Scan occlusal analysis system and virtual dental patient. The articulating paper, articulating film, articulating silk, high spot indicator, and metallic shim stock film are some of qualitative gauges [7].

In 1987, Maness developed the T-Scan system for computer occlusal analysis using the T-Scan intraoral sensor for recording and measuring in real time of occlusal forces [8]. The T-Scan III system is a dental device used to analyze relative occlusal forces that are recorded intraorally by a pressure-mapping sensors. The recorded force data are stored on computer hard drive and can be played back incrementally for data analysis in a time-based dynamic video. T-Scan III can assess the initial occlusal contact, the order that all the occlusal contacts occur in, and the amount of relative occlusal force loading each contact. Therefore, it enables us to assess the force changes during occlusal contact. Computer-guided occlusal adjustments can then be employed to alter a poorly contacting [9].

Prosthodontics rehabilitation involves confirmation of all phases from diagnosis toward intervening occlusion from temporaries to final prosthetic occlusion, and such occlusal confirmation can be carried out by occlusal analyzers [10].

The T-Scan III system makes it simply to operate, analyze the direction of the occlusal contacts from the moment of the first occlusal contact of teeth until making occlusal contact all the approach over to centric intercuspation. Furthermore, it displays any of anomalous forces which could lead to the dental trauma or pain in each tooth in the dental arch. This supports to balancing the forces among both sides of the dentition for optimal well-being, long-term efficacy of prosthodontics restorations. The T-Scan III system should be considered a highly accurate technique to study and analyze the occlusal and articulation relationships [11], [12]. The purpose of this review paper is to provide an overview of the T-Scan system over its utility in fixed restorations occlusal analysis.

Materials and Methods

An electronic search was performed through PubMed, MEDLINE, Web of Science, and Google Scholar from January 2013 to June 2021. The following keywords were used: “occlusal contact,” “articulating paper,” “occlusal force,” “occlusal contact distribution,”

“the T-Scan III occlusal analysis,” and “occlusal rehabilitation.” Those terms were combined by the operators OR/AND to widen the search field. The inclusion criteria for selection were articles reporting the occlusion analysis using articulating paper as a conventional method, and occlusion analysis using T-Scan III digital electronic system to detect contact points between the mandibular and maxillary teeth. Abstracts, case reports, review articles, and studies using other occlusal analyzers were excluded from the study. An initial screening through titles and abstracts was conducted independently by two reviewers. Disagreements, if present, were resolved through discussion. The search strategy involved three phases: Reviewing titles, selecting abstracts of interest, and final selection of articles for full-text detailed analysis. During the second phase, the abstracts that fulfill the purpose of this review were selected, and in the third phase, their full-text was analyzed.

Results

The electronic search identified 70 titles. Authors excluded 30 articles reporting T-Scan III in orthodontics than 20 articles were excluded reporting T-Scan III and implant occlusion. Likewise, 12 articles were excluded, because they used other occlusal analyzers to record the occlusal articulating relation. Finally, eight studies were identified as suitable for inclusion in this review. Table 1 presents that four studies chosen for presenting a comparison between the T-Scan III electronic system and articulating paper. Table 2 shows four studies about occlusal analysis using the T-Scan III electronic system.

Discussion

Over the years, a plethora of ideas, hypotheses, theories, and practical concepts about occlusion-associated topics have been accumulated

Table 1: Articulating paper compared with T-Scan III electronic system analysis

Article	Summary	Results
Rod Andrus <i>et al.</i> [14]	This clinical study compares the results of traditional occlusal adjustment techniques with those of computer aided occlusal adjustment technique	Significantly improved arch-half occlusal force equalization was obtained with computerized occlusal analysis than was obtained by the method only using marking paper, shim stock, and operator subjective assessments of the articulating paper marks
Buduru <i>et al.</i> [16]	In this clinical study after prosthetic treatment were clinically examined using Bausch articulating paper (100 µm and 40 µm thick) and the results were compared the T-Scan™M Novus™ device (TekScan).	Computerized T-Scan analysis may bring additional extremely valuable information regarding force intensity, the moment of occurrence and a much more precise localization
Dimova [20]	The study compares registration of occlusal contacts via articulating paper and the T-Scan system to evaluate the advantages and disadvantages of both methods in the occlusal diagnosis of patients with bruxism and bruxomania.	Registration with articulating paper visualizes the cumulative picture of the contacts in centric occlusion and interceptive contacts without being able to distinguish them in size and time of onset. Computerized occlusal analysis objectively and quantitatively determines interceptive contacts and distinguishes them from contacts in maximal intercuspation position and gives real meaning to the terms “strong” and “light” contact
Majithia <i>et al.</i> [17]		The ultimate advantage of a T Scan III analysis is that it can detect the amount of force as well as location of the highest intensity contacts

Table 2: Occlusal analysis using T-Scan III electronic system analysis

Article	Summary	Results
Liu <i>et al.</i> [15]	This clinical case compares the value of occlusal analysis in patients with bruxism and amelogenesis imperfecta according to the T-scan III system analysis before and after occlusal rehabilitation	The study indicated that the difference in bilateral force percentage before occlusal rehabilitation, after occlusal rehabilitation immediately, 4, and 10 months was 13%, 17.4%, 11%, and 16%, respectively. COFs after restorations were located within the ellipse.
Bicaj <i>et al.</i> [18]	This clinical study concerns the relation between the bite force and preferred chewing side among patients with permanent natural teeth	In this study, the relation between the preferred chewing side and occlusal force was found.
Doynu <i>et al.</i> [26]	The study evaluated the Premature Contacts by Using the T-Scan III	After occlusal adjustment, all patients' percentages of occlusal balance values was adjusted at an average of 48.8%, left 51.1%
Vesna <i>et al.</i> [27]	The study analyses the occlusal force and occlusal contact distribution over the course of time with the T Scan III System's precise analysis in subjects with neutroocclusion	The study concluded that analysis of masticatory cycle in time shows a tendency for force distribution towards the posterior region at the end of the bite.

and propagated in the dental literature. There is a lack of studies according to T-Scan occlusal analysis in fixed restorations. The significant component of occlusal development involves all modality of prosthetic reconstructions. In dental practice, articulating paper has been conventional as the most commonly used diagnostic device to detect contact points between the mandibular and maxillary teeth [13]. Many studies compare the results between articulating paper and T-Scan occlusal analysis. The articulating paper cannot accurately quantify the ratio and magnitude of the produced occlusal forces. The articulating paper can easily highlight the occlusal contacts between the teeth [14], [15]. Digital technology is becoming increasingly popular in our profession [16].

Dental occlusal analysis is an important factor for normal function of orofacial system. Any problem that makes a bite unstable causes pain, broken restorations, gum disease, tooth loss, headaches, and TMJ disorders [17], [18].

In his study, Neff [19] concluded that during the post cementation adjustments of a full-mouth reconstruction using all-ceramic restorations, the patient complained about the left side "feeling high. The articulating paper marked several contacts on the left side, but the T-Scan III showed that 60% of the force (right/left) was on the right side. Adjustments directed by the patient proprioception to the posterior left quadrant would have imbalanced the occlusion even more than 60% right to 40% left, possibly leading to fractures of porcelain or joint symptoms.

According to study [20], computerized occlusal analysis objectively and quantitatively determines interceptive contacts and gives real meaning to the terms "strong" and "light contacts."

Occlusal contacts are made when mandibular teeth are meshed with maxillary teeth. Nearby, contacts are those areas that range from a contact to a gap of 0.5 mm between the occluding surfaces, while noncontacts are those areas, wherein there is a 0.5–2 mm separation of the teeth. The true occlusal contact time by description suggests that a time of 0 s elapses between the first and the last occlusal contact, that is, all the occluding surfaces should be encountered at the same instant during the mandibular closure. Occlusal therapy aims to achieve this simultaneous occlusal contact relationship [21].

Ma *et al.* [22], in their study among patients with normal occlusion, concluded that at intercuspidal position the occlusal force centers were between the regions of first premolar and second molar. Moreover, the direct impact on occlusion may have also changed the morphology of the occlusal surface of premolars. Henceforth, the anterior guidance parameters and morphologies of molars could also influence the time of contact between the teeth during maximal intercuspation [23].

Many clinical studies show us importance of using T-Scan electronic system in occlusal analysis. According to studies, a computerized occlusal analysis system (T-Scan II, Tek scan Inc. S. Boston, MA, USA) provides the operator with a measurement-based method of obtaining objective occlusal contact relative force and real-time data, which has been shown to allow for more refined occlusal force equalization [15], [18], [24].

It is very important to successfully treat occlusion problems and enable patients to have a high quality of oral health after they receive dental restorations [25].

The T-Scan has been used in controlled studies to demonstrate its ability to provide better occlusal treatment than occlusal procedures governed by subjective interpretation [26], [27].

Conclusion

Based on the published literature, this review has highlighted some advantages of the T-Scan electronic system compared to articulating paper. The studies shows that the balance of occlusal forces is very important to achieve in patients with prosthetic restorations. Articulating paper, the most commonly used tool to identify contact points, cannot quantify their intensity and measure the magnitude of generated forces. T-Scan computerized occlusal analysis can provide quantifiable occlusal force and timing data that will make it possible to better protect brittle dental ceramic, and most importantly, to improve the quality of patient's lives with improved bite comfort and chewing function.

Authors' Contributions

All authors contributed correspondingly to this work. RH and JB contributed to conception, design, data collection, analysis, and interpretation of data. SH, SM, and ASH contributed to the analysis, interpretation of data, and critically revised the manuscript.

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