T- Scan a digital pathway to occlusal perfection: a review

Reeta Jain[1], Ravudai Jabbal[2], Shweta Bindra[3], Swati Aggarwal[4]

[1]Professor & Head, [2]Reader, [3,4]PG Student, Department of Prosthodontics, Genesis Institute of Dental Sciences & Research, Ferozepur(Punjab)

Corresponding Author:
Reeta Jain
Professor & Head, Department of Prosthodontics, Genesis Institute of Dental Sciences & Research, Ferozepur(Punjab)
E-mail: rtjn132@gmail.com

Abstract

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. These methods do not detect simultaneous contact, nor do they quantify time and force. With the advent of T-SCAN the scenario has changed. The evolution of T SCAN from 1st generation to 8th generation (1847-2015) has revolutionized the concept of occlusal analysis. The modern version of T SCAN system released in 2012 i.e. T SCAN 8 was purposefully designed to minimize the T SCAN 3 user interface complexity. T SCAN 8 has reversed desktop graphics for simpler data display with less software, toolbar buttons and icons. The system comprises of Microsoft windows based software, associated hardware and patented thin disposable sensor. Patient is asked to bite on ultra-thin senor. The occlusal contact is transferred to the computer and presented in a dynamic movie format. It thereafter allows for full color 3 or 2 dimensional graphics. It depicts the percentage of force per tooth. The software enables the doctor to dynamically visualize the patient bite from beginning to end and everything in between. The analytic software displays such as centre of force (COF) and COF trajectory provides an in depth understanding of the overall balance of occlusion.

Key words: *T-Scan, Digital Occlusal Analysis, Bite force.*

Introduction

The conventional methods used in clinical practice for guiding contact selection during occlusal adjustment are using articulating paper, impression waxes and shim stock foil which are all often combined with patient occlusal feedback. The use of articulating paper is most commonly method used to determine excessive force in differing occlusal contacts[1]. Despite the apparent clinical success with use of paper mark size as an occlusal contact selection guide, it appears that using mark size as a force guide can result in poor force applications to the occlusion. Published studies about articulating papers are analyses of the physical properties (thickness, composition, ink substrate and plastic deformation)[2],[3],[4]. In this era of immobile dental implants and brittle all ceramic restorative materials more precise occlusal force control is required to ensure the longevity of prosthesis. One of the most innovative systems for quantitative occlusal analysis was developed by Maness. He developed the T- Scan system, which is considered as a computerized device capable to interpret occlusal

contact information quantitatively.[5] T- Scan l was invented 25 years ago, and since then, the entire system has undergone hardware and software revisions such that today T-Scan lll system (version 7) is vastly improved over the earliest T-Scan l system.[6]

The occlusal forces that are applied to an implant prosthesis can be a potentially destructive factor in shortening the potential longevity of any implant prosthesis. Both material failures and implant deosseointegration have been attributed to excessive occlusal loading to dental implants[7,8]. Poorly directed and non-uniform occlusal loading will torque a prosthesis and apply stresses that may ultimately result in prosthetic failures. With the aid of the T-Scan II Occlusal Analysis System, occlusal forces that are applied to an implant prosthesis can be quantitatively represented for improved correction through occlusal adjustments. The resultant occlusal force distribution can then be far less destructive to the prosthesis, and the underlying implant-bone interface.

One of a doctor's roles is to educate patients with regards to their health (ADA, 2010). The

three most prevalent diseases dentists regularly treat are caries, periodontal disease and occlusal disease (Christensen, 2001). Occlusal disease is under treated by many practitioners (Christensen, 1995), which is partially due to the difficulty of having a patient understand the benefits that occlusal therapies offer in the treatment of occlusal pathologies. Utilizing the T-Scan Computerized Occlusal Analysis System (T-Scan 8, Tekscan, Inc. S. Boston, MA, USA) in combination with a well-planned strategy for patient education, can improve the number of patients who accept occlusal therapies that likely would benefit them.[9]

Imaging technology in the form of T Scan device can reveal much of the invisible world of occlusion and associated diagnostic capability. Many of the most influential tooth contacts in occlusion are so subtle that they cannot be identified through simple observation.[10]

Applications
- Abfraction Formation and Root Recession Defects
- Adhesive and Esthetic Prostheses
- Cosmetic Restorations
- Full Mouth Reconstruction
- Implant Prosthodontics
- Natural Tooth Occlusal Function
- Orthodontics
- Prosthodontics
- Splint/Orthotic Therapy
- Temporomandibular Disorders

Benefits
- Improved diagnosis
- Increased quality of care
- Decreased treatment time
- Increased comfort of dental prosthetics
- Reduced risk of implant failure, traumatized teeth, unstable dentures, ineffective splints, and porcelain fractures
- Legal documentation of outcome
- Enhanced patient education
- Build your practice
- Increased referral business from other physicians

Windows System Requirements
Based Virtual Windows Based
- Windows XP, Vista, 7 and 8

- Intel

Core™2 Duo Processor or newer
- a2 GB RAM
- 5 GB Disk Space
- Dedicated video card

(2011 or newer)
- VMware
- MacBook Pro

5 or Parallels
Desktop 7
Virtualization Software
- 8 GB RAM
- 75 GB

System Components
- Software CD
- 1 Evolution Handle (USB-based)
- 20 T-Scan Sensors – 1 box each large and small
- 4 Sensor Supports – 1 box each large and small
- Dental Practice Marketing Kit CD
- Hands-on and online training sessions included

Discussion
Reliability and reproducibility of occlusal analysis is an important dimension of planning evidence-based clinical decisions, in clinical dental treatments and research.[11] 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.[12]

Although the role of occlusal disturbances as one of the etiological factors in the multifactorial TMDs is controversial,[13] correction of the occlusal disturbance in various cases has been shown to reverse the condition and provide relief to the myalgia.[14] It has been shown that lower surface electromyographic (SEMG) activity is associated with higher number of contacts and the maximum level of bite force during centric maximal voluntary clenching.[15] The T-Scan system presents a superior alternative to conventional occlusal registration methods due to its ability to record dynamic tooth contact relationships.[16] 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.[17] This establishes the inadequacy of AP marks in describing the occlusal load.[16] T-Scan has a higher sensitivity and specificity as a diagnostic tool for assessing guided closure contacts, when compared to articulating paper, waxes and other conventional occlusal indicators.[18]

Although the T-Scan sensors are available in two different sizes to accommodate arches of different dimensions, the literature search did not identify any articles reporting the use of this system in children and patients with limited mouth opening and hence, no conclusions can be drawn about their benefits or limitations in these cases. An important aspect of the T-Scan system that should be considered is that the contact timing and the force analysis can be studied on the software. Thus T-Scan is able to provide a definitive diagnosis of the occlusal force balance and masticatory muscular function.[19, 20]

The product is now marketed in its third version as T-Scan III with software version 8.0. Moreover, the newer software provides a better representation of the intraoral dental arch in the analysis program of the software when compared to previous versions.[21]

Safety Issues

T-Scan systems are classified as Class I devices by the FDA. They have low-risk profiles since they are not "life-supporting, life-sustaining or of substantial importance in preventing impairment of health nor present a potential unreasonable risk of illness or injury".

Limitations of the T-Scan System

It has been shown that thinner occlusal registration materials provide more consistent records of the contact points. To fulfill the technological demands, the T-Scan sensors are made as thin as possible (0.1mm). However, these sensors are still relatively thicker as compared to occlusal indicators like articulating silk. This may significantly alter the functional occlusion and even affect the activity of the masticatory muscles. Alteration of occlusion is shown to occur with all occlusal registration products, and clinicians should be aware of these limitations when functional adjustments are planned in the occlusion. Furthermore, the sensors may be damaged when forces are concentrated over a small area, such as, a sharp tooth cusp. This is due

to increased intensity of otherwise relatively low bite forces which become focused onto a small area and produce high pressure. This may also lead to inaccurate recording of the occlusal contact and/or artifacts in the produced images. The T-Scan system is able to reproduce occlusal interferences only exceeding 0.6mm in dimension. Also, the two different modes of the system (force and time analysis modes) may reproduce different occlusal contact data. Time mode has been shown to register the maximum number of contacts, while the force mode has been shown to present the least variability. However, these differences are small.

Conclusion

Compared to conventional occlusal indicators, the T-Scan system clearly has more clinical utility in diagnosing and treating cases of temporomandibular disorders when caused due to occlusal disturbances. Computerized occlusal analysis with the T-Scan II can be applied to analyze the relative time of initial occlusal contact of natural teeth and dental implant prostheses, so that it is possible to separate them as they come under occlusal loading. T-Scan system demonstrates sufficient sensitivity and specificity as a diagnostic tool and presents higher reliability in intra-oral conditions with presence of saliva. This technology reduces the subjective interpretation of occlusal analysis data and also provides registration of dynamic occlusal information. Therefore it is recommended that the use of T-Scan system should be supported in clinical practices for the diagnosis and occlusal optimization in cases of occlusal disturbance related temporomandibular disorder, due to its capability of measuring occlusal force and contact timing.

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