Indian Journal of Dental Sciences.
June 2013 Issue:2, Vol.:5

www.ijds.in

Review Article

Indian Journal
of Dental Sciences

E ISSN NO. 2231-2293 P ISSN NO. 0976-4003

Computerized Occlusal Analysis

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Submission : 1st August 2012
Accepted : 20th March 2013

Quick Response Code

Abstract
Perfect occlusion is an elusive concept in a system based upon neuromuscular control that is constantly adapting and responding to function, trauma and higher central nervous system control. Computerized occlusal analysis has been presented to market as an innovative, computer aided device, capable of providing exact information regarding position, strength and frequency of occlusal contacts. Because of rapid and accurate ability of this system to identify distribution of tooth contacts, it shows great promise as a clinical diagnostic screening device for occlusion. This article reviews the research and the clinical applications of computerized occlusal analysis. Pubmed and Google scholar were used to find the original research, case reports and reviews about computerized occlusal analysis. The keywords used were computerized occlusal analysis, T –Scan and occlusion.

Key Words
Computerized occlusal analysis, T –Scan, Occlusion

Introduction

The conventional methods used in clinical practice for guiding contact selection during occlusal adjustment are using articulating paper, impression waxes and Shimstock 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].The interpretation of articulating marks has been an inexact science[2]. These ink marking systems illustrate the contact location and to some degree contact surface width. 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) [3],[4],[5]. But no scientific evidence shows that articulation paper mark size or mark appearance characteristics can accurately describe varying occlusal loads[6]. Additionally when articulating paper is employed it is subject to fragmentation and perforation during intercuspation showing that it's marking repeatability is poor[7].

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. Through a menu driven software, the T-Scan system uses a sensor unit that records occlusal contacts on a thin Mylar film and relays the information to the computer. The recording sensor is placed intaorally between the dental arches, to capture real time, occlusal force and time sequence data, when subject intercuspates or makes excursive movements, across its recording system .The software processes the occlusal data of any recorded occlusal event for graphical display in two and three dimension. The recorded occlusal force data offers the operator improved information about occlusal contact locations. Through analysis of the occlusal contacts it is possible to determine the sequence and timing of which teeth contact and with what degree of comparative force[8].

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[9].The T-Scan lll analyzes the order of occlusal contact, while simultaneously measuring the force percentage changes of those same contacts, from the moment the teeth first begins with making occlusal contact, all the way to the maximum intercuspation. Therefore it can assess the initial occlusal contact, the order that all occlusal contact occur in, and the amount of relative occlusal force loading each contact. It enables us to assess force changes, all during the process of contact evolution. Computer guided occlusal adjustment can then be employed to alter poorly contacting tooth sequence into contact sequence where multiple equal-intensity contacts are occurring simultaneously throughout the arches bilaterally[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. The clinical challenge is to prevent the consequences of occlusal discrepancies by making appropriate, evidence based and minimal adjustment to deliver a realistic treatment with reliable outcomes.

Method of collection of data

A search of original articles, case reports

and reviews about computerized occlusal analysis were used from pub med and Google scholar from 1987 to 2012. The following key words- computerized occlusal analysis, T-Scan were used for the search.

Review of literature

Maness (1987) et al described the use of T-Scan and stated that it uses both force and time to quantify occlusal contacts[10].

Maness WL, Podoloff R (1989) described the use of the T- Scan system to record and analyze tooth contact data by calculating time moment statistics in the sagittal and transverse axes of occlusal plane and reports the use of this method to analyze the occlusion of 93 subjects. They stated that T-Scan shows rapid and accurate ability to identify the distribution of the tooth contacts and shows a great promise as clinical diagnostic screening device for occlusion[11].

Chapman RJ(1989)[12]described that T-Scan system quanitifies occlusal contact timing and force, thereby it can aid to accomplish the following goals of implant prosthodontic occlusion:

- Bilateral simultaneous contact at the time of insertion.
- Smooth even working contacts with no interfering contacts in Retruded Contact Position or Intercuspal Position.
- Equality of force of the final contacts
- Records of monitoring occlusal contact over time for bilateral simultaneous contact and force distribution

Maness (1991) compared the performance of computerized occlusal analysis system with accufilm and shim stock foil for registration of tooth contacts on a laboratory model. According to him the traditional methods were similar to the computerized occlusion but the system provided additional differential diagnostic information in force and time models for an improved occlusal analysis[13].

Howard et al (1991) conducted a study to investigate the effect of sagittal plane neck posture on initial tooth contacts using the T-Scan system of occlusal analysis. Results of the study indicated that below the age of 30 there was no significant relationship between head posture and muscle contact position. However over the age of 30 there was increasingly significant relationship between sagittal plane head- neck posture and initial tooth contacts[14].

Harvey et al (1991) evaluated the validity and reliability of sensors used in computerized occlusal analysis system and discovered that sensors were valid when used just twice[15].

Lyons et al (1992) evaluated compute rized occlusal analysis system .An evaluation of this system was described with particular emphasis on the measurement of bite force. It was concluded that system does not measure force accurately but is useful clinical tool if used with care[16].

Yahmura M (1992) conducted a study to determine the accuracy and reproducibility of occlusal marking using T-Scan system. The study was conducted on four specific points loaded on a sensor by application of the weight of 0.1 kg through 10 kg .The results showed the most sensible areas can be measured from .1 to 2.1kg.Thus device was considered to be more suitable for recording within lower loading[17].

Mizui M, Nabeshima F, Tosa J, Tanaka M ,KawazoeT(1994) used T Scan system to evaluate the distribution of time and force in occlusal balance. Sixty normal subjects demonstrated the bilateral balance and an antero- posterior centre of force in first molar region. The computerized analysis system was found to be clinically useful as diagnostic screening method for occlusal stability in intercuspal position[18].

Gracia Cartagena et al(1997) studied the value of T -Scan computerized system as method for exploring occlusion .Number of contacts was recorded in 31 subjects using the two operation modes enabled by T -Scan. They stated that the number of occlusal contact is significantly different for each patient both in various mandibular positions and in the force and time analysis modes[19].

Kerstein RB, Wilkerson DW (2001) described a method of locating centric relation prematurity. They used bimanual manipulation with simultaneous recording of sequence of resultant tooth contacts using computerized occlusal analysis system. According to them this method offers significant improvement in the precision of locating the first tooth contact[20].

Kenji O (2002) conducted a study to assess the reproducibility of T- Scan ll system and its clinical usefulness for evaluating the occlusal contacts of complete denture wearer's .The occlusal contacts of 13 dentate and 14 complete denture wearers were recorded during maximum voluntary clenching. Results revealed maximum load testing of .3sec for dentate and .8 sec for complete denture subjects. It was revealed that T-Scan ll showed acceptable reproducibility and it was useful to evaluate occlusal contacts of complete denture wearers[21].

Kerstein (2004) described the synchronization of computerized occlusal analysis and electromyography recording system. The simultaneous recording and playback capacity of these two computer systems allows the operator to analyze and correlate specific occlusal movements to specific electomyographic changes that result from these occlusal movements .This provides unparallel evidence of the effects of occlusal contact arrangement on muscle function[22].

Garg A K (2007) stated that T- Scan occlusal analysis system can help in measuring occlusal biting force, and also aid in obtaining consistent and useful occlusal data for placement, analysis and repair of dental implants[23].

Kerstein RB(2008) concluded that when inserting Cerec restoration computerized occlusal analyses can be employed to target excessive force concentrations and time premature contacts to preserve the restoration[24].

Julia Cohen, Nicolas Cohen (2011) in their study on lingual orthodontics used T Scan lll for occlusal analysis. They found that T-Scanlll records showed high reproducibility[25].

T scan technology

Computerized occlusal analysis system uses both time and force to quantify occlusal contacts[10]. Its use enables refinement of an occlusion that is bilateral and simultaneous in RCP or IP. The computer identifies balancing

contacts and displays the magnitude of occlusal forces so that they can be appropriately distributed .The T-scan is a computer with a color monitor that uses a sensor technology to quantify the occlusal contact data. The sensor is made of two layers of 25 micrometer Mylar film printed with horizontal and vertical silver traces to form a grid pattern. A force ink between the silver traces allows increase current flow between the traces when pressure is applied .A minimal current level is interpreted by the software as a contact. Because 70 micrometer a current is cycling through the sensor every 0.01 second, the timing of any occlusal contact can be determined within a 0.01 second time frame .The distance between the silver traces is 1.25mm. Therefore the location of any occlusal contact register will be within a radius of 0.67mm.Software displays both the timing and force of the occlusal contacts in two separate modes[12].

Time mode

The time mode immediately displays all the contacts and highlights the first three contacts with their relative time values. Contacts can also be looked at in the three dimensional display to examine the time differences qualitatively

Force mode

When the patient closes on the sensor in the force mode, electrical resistance decreases as occlusal pressure is applied. The resistance change calibrated to display the lowest force level is approximately 100gm at any one contact point. The upper limit of force discrimination at any one point is 1.1kg. The different level of force is displayed on three dimensional screen as variation in height of the columns.

The occlusal contact data that is transferred to the computer and presented in movie format allows for play back in vivid, full color three dimensional or two dimensional graphics. The T- scan playback identifies percentage of force per tooth, dental arch half, and quadrant. The software enables the doctor to dynamically visualize the patients bite from beginning to end and everything in between. This allows the clinicians to adjust occlusion and to provide better restorative services, functionally balance teeth and positively influence muscular activity, and provide periodontal support, all with high degree of precision[26].

Clinical application

During maxillomandibular inter cuspation, time and force are the main occlusal factors the T- scan can measurably isolate. It readily identifies the very first contact point that precedes numerous other contact points that occur transitory during maxillomandibular functional movements

Since the introduction of T-Scan in 1987 the use of computerized occlusal analysis has gained importance in occlusal therapy, TMJ disorder and treatment, fixed, removable, implant prostho dontics.

With T-Scan capabilities clinician can:

- Record the patient occlusal contact data
- View the patient tooth contacts and associate them with specific teeth
- Analyze the data force and time relationship of the contacts that are displayed as color contour movies
- Manage patient records and movie files through use of intuitive database
- T -Scan is a great tool to ensure that loading of implant is after the natural dentition. Kerstein and Kirveskeri have proposed a quantifiable time delay so that natural teeth occlude in advance of implant prosthesis[27],[28].
- The T- Scan system can provide the dentist a timely examination of the interdental forces in the patients that manifest force related problems. The T- Scan reflects the abnormal dysfunction of musculature directly with electromyography synchroni zation or indirectly via center of force pattern and disclusion timing.
- In laboratory, computerized occlusal analysis can be used to verify paper and visual observations to ensure even distribution of occlusal contacts and detect posterior interferences in protrusive and lateral movements[29].
- T- Scan can be used by dental hygienist to take screenings on patients. This allows the clinican to gain in depth understanding of the patients existing situation and facilitate treatment
- It also provides a very easy, graphic way to interact with patients on presence of issues affecting their condition by providing excellent documentation and communication.

Summary

Computerized occlusion analysis is becoming the principal tool available to clinicians with which to understand functional and parafunctional forces of occlusion contact, contact timing sequences, and occlusal surface pressures, which arise as teeth mill against each other during mandibular movements. Recent research on articulating paper has revealed that articulating paper marks size does not measure occlusal forces predictably the modern clinicians need to employ an occlusal contact measuring device that can reliably determine aberrant occlusal force concentration and time prematurities. Computerized occlusal analysis can be used to guide the operator as to which tooth contact locations requires appropriate occlusal adjustments.

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Source of Support : Nill, Conflict of Interest : None declared