Chapter 3.18
Time-Sequencing and Force-Mapping with Integrated Electromyography to Measure Occlusal Parameters

Robert B. Kerstein[1]
Tufts University School of Dental Medicine, USA

ABSTRACT

Computerized Occlusal Analysis technology records, and quickly displays for clinical interpretation, tooth contact timing sequences of .003 second increments, and each tooth contacts' fluctuating force levels which occur during functional jaw movements. These measurements are recorded intraorally with an ultra-thin, mylar-encased sensor that is connected to a computer via a USB interface. This sensor is placed between a patients' teeth during functional jaw movements to record changing tooth-tooth interactions. The displayed occlusal data aids in the examination and treatment of occlusal abnormalities on natural teeth, dental prostheses, and dental implant prostheses. The software can be linked to an Electromyography software program that simultaneously records the electromyographic potential of 8 head and neck muscles. This combination of dynamic tooth contact force and time data, and functional muscular data, affords a dentist detailed, precise, and unparalleled diagnostic and treatment information, with which to address many differing clinical occlusal pathologies.

DOI: 10.4018/978-1-60960-561-2.ch318

INTRODUCTION

Computerized Occlusal Analysis technology (T-Scan III for Windows®, Tekscan Inc., S. Boston, MA, USA) records, and quickly displays for clinical interpretation, tooth contact Time-Sequences while simultaneously Force-Mapping each tooth contacts' fluctuating *relative occlusal force* levels which occur during functional jaw movements (*known as* Occlusal Events) (Maness 1993, Montgomery and Kerstein 2000, Kerstein 2001, Kerstein and Wilkerson 2001). These *occlusal event* measurements are recorded intraorally, with an ultra-thin, electronically charged, mylar-encased sensor that is connected to a computer via a USB interface.

By measuring *Relative Force*, the T-Scan III system can detect whether an occlusal force on one set of contacting opposing teeth is greater, equal to, or less than, the occlusal forces occurring on other contacting teeth all throughout the dental arches. Determining relative force is important to the user-Dentist, as relative force illustrates measured differences of varying applied loads within all contacting tooth locations. The T-Scan III software displays the relative occlusal force, at any instant within a recorded occlusal event on all contacting teeth, as a percentage of the maximum occlusal force obtained within the recording.

Detected relative force variances can be employed clinically to:

- Precisely balance an unbalanced occlusal force distribution with targeted time-based and force-based occlusal adjustments
- Diagnose excessively high occlusal load present in one area of the occlusion, while simultaneously diagnosing where there is little, moderate, or no occlusal load in other areas of the same occlusion

After various occlusal events are recorded, the retrieved occlusal contact time-sequence data and relative force data are mapped for analysis in 4 different quantifiable ways:

- By real-time increments that measure the sequential order of each individual tooth contacts' loading occurrence. The real-time sequence can be separated into increments as short as .003 seconds duration
- By *force location* on the contacting surfaces of many teeth individually and collectively within the 2 dental arches
- By relative changing *force percentage values* on all individual contacting teeth
- By a changing, moveable *occlusal force summation icon* and trajectory, that describes the changing concentrated force position within the 2 dental arches of all the collective tooth contacts' relative occlusal forces

The mapped contact time-sequence and relative occlusal force data, when analyzed by a user-Dentist, aids in the clinical determination of, and occlusal treatment of, many time premature contacts, and occlusal force abnormalities, which occur during occlusal events on natural teeth, dental prostheses, and dental implant prostheses (Kerstein Chapman and Klein 1997, Kerstein 1997, Kerstein and Wilkerson 2001, Kerstein and Grundset 2001,).

This technology's ability to isolate time-premature tooth contacts, and excessive occlusal contact forces, is vastly superior to the commonly utilized, non-technology based occlusal indicators which dentists routinely employ (articulating paper, wax imprints, silicone imprints, and articulated stone dental casts). None of these dental materials have any scientifically proven capability to time-sequence tooth contacts, or force-map occlusal forces. Additionally, they all necessitate the user-Dentist to "subjectively interpret" their occlusal representations.

The most commonly employed occlusal indicator is dental Articulating Paper. It is comprised of