

Chapter 3

T-Scan System Accuracy Studies

Bernd Koos

Head of the Orthodontic Department, Eberhard Karls University, Germany

Robert B. Kerstein

 <https://orcid.org/0009-0005-5209-5958>

Former Assistant Clinical Professor, Tufts University School of Dental Medicine, USA

ABSTRACT

The precision analysis of occlusal contacts and occlusal force is a problem in functional diagnostics that has not yet been satisfactorily resolved, despite the fact that the deleterious consequences of an unbalanced occlusion are widespread and can be severe. In clinical practice, the present-day analysis of the occlusion is reduced to depicting force with color-marking foils that leave ink marks upon the teeth. However, these foils and papers only indicate the localization of contacts, but do not describe reliably the occlusal force relationships. Precise analysis that incorporates time resolution, and plots the distribution of forces within the occlusion, is not possible when employing the traditional occlusal indicator methods. A detailed occlusal force and timing analysis can however be provided by performing a computer-assisted analysis, using the T-Scan occlusal analysis system, which records changing relative occlusal force levels and real-time occlusal contact sequence data with high definition (HD) piezoelectric recording sensors. This chapter includes five different T-Scan system force reproduction studies (2 T-Scan III studies, 1 T-Scan 9 study, and 2 T-Scan 10 Novus studies), three T-Scan Time-based quantification studies, and one repeatability and reproducibility bench analysis comparing T-Scan 10 Novus to the Occlusense system. Taken all together, these studies demonstrate the accuracy, repeatability, and consistency of this high-precision computer-based occlusal function measurement method.

INTRODUCTION

A smooth and functional occlusion is basic and central to all sub-disciplines of dentistry, including orthodontics (Andrews, 1972). In conservative restorative dentistry, the presence of a harmonious and smooth occlusion is considered essential to the physiological function of the Stomatognathic system, and is deemed essential to protect against excessive loading and fracture of inserted restorations and dental implants. In orthodontics, harmonious occlusal relationships are required to ensure the stability of achieved treatment outcomes. It is a vital element of therapeutic dentistry to accurately and realistically

DOI: 10.4018/978-1-6684-9313-7.ch003

record and analyze the occlusal relationships of examined patients, by the use of occlusal indicators (foils, papers, silk ribbon) or instrumental occlusal diagnostics. This chapter will focus mainly on the reproducibility and reliability of methods. What follows is an analytical presentation of the temporal sequence of occlusal force buildup that can be observed with the T-Scan occlusal analysis systems (Tekscan, Inc. S. Boston, and Norwood, MA, USA). This topic will be discussed against the background of the available literature regarding the conventional, non-digital, occlusal indicator diagnostic methods.

SECTION ONE: OCCLUSAL INDICATOR LIMITATIONS

The problem of how to precisely analyze occlusal contacts for functional diagnosis has not been acceptably solved to this day (Balters, 1955; Gazit, Fitzig & Lieberman, 1986; Komari, 1978; Millstein, 1983; Reiber, Fuhr, Hartmann & Leicher, 1989). No occlusal aids other than color-marking foils, articulating papers, and silks were formerly available for clinicians to check occlusal contacts in daily clinical practice. While indicators of this type disclose the location of contacts, they provide no information about the relative occlusal forces, nor the timing of the contact sequences. Given a mere 21% reliability relating the size of articulating paper markings to differing occlusal force levels, any conclusions drawn on this basis have been described as “tantamount to clinical guessing” (Carey, Craig, Kerstein, & Radke, 2007; Kerstein, 2008; Kerstein & Radke, 2013; Sutter, 2017; Basson, Kerstein & Radke, 2020). A recently published analysis confirmed the poor relationship between mark size and occlusal force, reporting only a 10% correlation (Thanathornwong, 2020). Due to this inadequate representation of force levels present at contact points relative to the markings on tooth surfaces, the usefulness of these indicators should be solely confined to their role as contact locators.

In addition, the markings offered by these foils and strips are not adequately reproducible, but will somewhat increase in reliability at higher force levels (Gazit, Fitzig & Lieberman, 1986; Millstein & Maya, 2001; Reiber, Fuhr, Hartmann & Leicher, 1989). Moisture and repeated use, in particular, will considerably impair the sensitivity of conventional occlusal indicators (Saracoglu & Ozpinar, 2002). Reiber, et. al., determined, that foil markings offer more accurate marks than those made from papers and silks, but paper indicators will yield better results than foils when marking glossy surfaces, such as with abraded wear facets and highly polished restorations, because the dye released from foils marks less predictably in those clinical situations (Reiber, Fuhr, Hartmann & Leicher, 1989). Since tracings created by foils are also unpredictable in the presence of low or impulse-free loading, higher forces need to be exerted (such as with chopping movements), introducing an additional source of error to the occlusal analysis (Reiber, Fuhr, Hartmann, & Leicher, 1989).

Despite that, it has been suggested that these conventional foil and articulating paper techniques will yield reproducible results at an acceptable level of variance, in the hands of “*adequately experienced and prudent clinicians*” (Tschernitschek, Handel & Gunay, 1990), modern studies strongly indicate that the clinical interpretation of occlusal indicator markings is highly subjective, and dental clinicians perform Subjective Interpretation quite poorly. 3 separate investigations involving nearly 600 dentists revealed that dentists *chose incorrect contact force levels* when observing articulating paper ink markings 87% - 95% of the time. These 3 separate studies illustrate that choosing contact force levels visually is highly error prone (Kerstein & Radke, 2013; Sutter, 2017; Basson, Kerstein & Radke, 2020)

88 more pages are available in the full version of this document, which may be purchased using the "Add to Cart" button on the publisher's webpage:

www.igi-global.com/chapter/t-scan-system-accuracy-studies/363264

Related Content

Digital Occlusion's Role in Implant Rehabilitation

Henriette Lerner (2025). *Handbook of Research on T-Scan Technology Applications in Dental Medicine* (pp. 2163-2274).

www.irma-international.org/chapter/digital-occlusions-role-in-implant-rehabilitation/363278

Image Segmentation Using Contour Models: Dental X-Ray Image Segmentation and Analysis

Kavitha G., Muthulakshmi M. and Latha M. (2019). *Computational Techniques for Dental Image Analysis* (pp. 62-85).

www.irma-international.org/chapter/image-segmentation-using-contour-models/216043

Occlusally Educating Both Patients and Clinicians With the T-Scan Technology

John Droter (2025). *Handbook of Research on T-Scan Technology Applications in Dental Medicine* (pp. 3057-3116).

www.irma-international.org/chapter/occlusally-educating-both-patients-and-clinicians-with-the-t-scan-technology/363287

The Limitations of Static Traditional Occlusal Indicators Compared to the Advantages of Quantifiable Dynamic Occlusal Indicators

Sarah Qadeer (2025). *Handbook of Research on T-Scan Technology Applications in Dental Medicine* (pp. 107-186).

www.irma-international.org/chapter/the-limitations-of-static-traditional-occlusal-indicators-compared-to-the-advantages-of-quantifiable-dynamic-occlusal-indicators/363263

Orthodontic Monitoring and Case Finishing With the T-Scan System

Julia Cohen-Levy, DDS (2020). *Handbook of Research on Clinical Applications of Computerized Occlusal Analysis in Dental Medicine* (pp. 1057-1124).

www.irma-international.org/chapter/orthodontic-monitoring-and-case-finishing-with-the-t-scan-system/233666