Review Article

The Magical Era of T Scan in Dentistry – A Literature Review

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ABSTRACT

Occlusion is a decisive factor for oral health and temporomandibular joint (TMJ) wherein assessing occlusion is critical. For years, various occlusal indicators are available such as articulating paper, pressure-sensitive paste, and waxes with many vital limitations. In 1987, Maness introduced T scan to overcome these limitations. T scan consists of a recording handle, sensor holder, high definition sensors, and Universal Serial Bus port to connect to computer/laptop. It has transformed the landscape of occlusal analysis, offering a dynamic, quantitative method for assessing bite force distribution. Its applications in diagnosing occlusal disease, managing TMJ disorders (TMD), and enhancing restorative and orthodontic treatments make it a valuable tool in modern dental practice. Moreover, it precisely pinpoints the excessively forceful contact locations and displays them for analysis in a colorful three-dimensional view thus helping the diagnostician. This review outlines the critical components of the T scan system and its practical applications in dentistry. It also explores the role of T scan in enhancing the diagnosis and management of occlusal disorders, prosthodontics, orthodontics, and TMD.

Key words: Occlusal discrepancies, Occlusion, T scan, Temporomandibular disorders

INTRODUCTION

Dental restorations, orthodontic procedures, and the health of the temporomandibular joint (TMJ) are all impacted by occlusion, which is crucial to oral health. A balanced dental occlusion is essential to the masticatory system's proper operation.[1]

In addition to the morphological contact interactions between teeth, the concept of occlusion encompasses the dynamic morpho-functional interactions among all the components of the masticatory system, such as the neuromuscular system, the periodontal tissues, the teeth, the temporomandibular joint, and the craniofacial bones.[2]

Occlusal trauma is typically caused by abnormal occlusal contacts and an excessively high occlusal height of a restoration.[1] Atypical protrusive interferences can cause myalgia, or discomfort in the muscles, by shifting the mandible into a posture that is physiologically unsound or by negatively affecting the temporomandibular joints.[3]

Pain, limited jaw movement, and joint sounds are symptoms of a set of musculoskeletal illnesses known as TMJ disorders (TMD).[2] Occlusal imbalances are frequently the cause of TMD, which puts tension on the TMJ and nearby muscles. Conventional occlusal examination techniques, like articulating paper, are not very accurate at identifying the timing and severity of tooth interactions.[4]

The occlusal analysis tool used in dentistry is called the T scan. Clinicians can obtain precise 2D and 3D representations of bite forces with temporal information in relation to the dental occlusion thanks to this dental scan technology.[5]

Clinicians can now analyze occlusion quantitatively and dynamically thanks to the development of T-scan technology, which offers new insights into diagnosis and therapy planning.[3] In contemporary dental practices, it is crucial for diagnosing occlusal problems and maximizing treatment regimens in orthodontics, restorative dentistry, and TMD management.[4]

WHAT IS A T SCAN?

T scan, the first grid-based sensor technology specifically designed for occlusal analysis, was developed by Tekscan in 1987 in response to the dentists' need for an accurate way to dynamically measure occlusion.[1] In 1984, Maness *et al.* introduced the development of pressure-sensitive ink-Mylar-encased sensor technology with their T-Scan® I computerized occlusal inspection system.[2]

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Over the course of the last three decades, T-scan technology has evolved from T-scan I in 1984 to T-scan II for Windows in 1995, T-scan III (software versions 5, 6, and 7) in 2004, Turbo recording development in 2008, and T-scan 8, which was released in 2014 (Tekscan Inc., South Boston, MA, USA).[5]

In 2015, the T-scan handpiece model was upgraded to T-scan Novus (software version 9.1), and the most recent version, T-scan v10, was released in 2018. Up until the current iteration of the system, T Scan III, the original T scan system architecture underwent numerous hardware and software improvements.[4]

T scan is a digital occlusal analysis method that uses a pressure-sensing device positioned between the patient's teeth while they bite to capture the occlusal contact force, timing, and distribution.[6] In contrast to traditional techniques, it provides a more accurate evaluation of occlusal interferences by enabling the real-time viewing of biting forces.[5]

To record occlusal contact points, a thin, pressure-sensitive sensor is positioned between the patient's teeth while they are biting.[1] The information is shown as a dynamic, color-coded map that shows the contacts' order and biting severity. It offers a more accurate assessment of occlusal interferences, which could be causing TMD symptoms, in contrast to conventional techniques.[3]

T SCAN DEVICE

It has a Universal Serial Bus port for connecting to a computer or laptop, a recording handle, a sensor holder, and high definition (HD) sensors.[1] A grid of resistive ink rows and columns is printed between two layers of Mylar that make up the structural design of the HD sensor. Two sizes are available for the sensor's manufacturing: Small for thin mediolateral and short anteroposterior dental arches, and large for broad mediolateral and long dental arches.[7]

From the initial point of contact to the highest intercuspation, the closure sequence is recorded by computerized occlusal analysis technology.[3] While the force mapping data can be used to objectively find powerful occlusal contacts, these closure data can be utilized to examine and interpret the time needed for the teeth to accomplish complete intercuspation.[5]

While giving the clinician objective, measurable occlusal force and timing data to help with accurate and focused occlusal diagnoses and corrective adjustments, the dynamic three-dimensional and two-dimensional graphic display also functions as a thorough educational tool for patient comprehension.[6]

To accurately identify the locations of excessively forceful contacts, T-scan occlusal force, and timing data eliminate the need for subjective interpretation of contacts using articulating paper marks.[7] These contacts are then displayed for analysis in a three-dimensional view as columns of varying height, ranging from low force, which is represented by small blue columns, to high force, which is represented by tall red and pink columns.[4]

To evaluate bilateral time and force simultaneity, bilateral force equality, and the overall occlusal force distribution, the two-dimensional force view shows the fraction of force on individual tooth, quadrant-wise, inside each arch.[8]

In addition to increasing the accuracy of the clinician's corrective adjustment outcomes, this visual display piques the patient's interest.[3] The patient is able to visually assess their own non-uniform occlusal force distribution because they can understand the areas of high force that are represented by the different colors (for example, green indicates moderate force, yellow indicates moderately high force, red indicates high force, and pink indicates an unknown amount of high force).[1]

When the patient actively cooperates, understands, and accepts the necessary remedial treatment, it helps with clinical case management.

APPLICATIONS OF T SCAN

Diagnosis of occlusal discrepancy

Patients frequently experience discomfort and damage due to occlusal loading, tooth wear, and bite-related problems. Clinicians can use T-scan to assess and locate high-pressure occlusal sites, which may result tooth problems like periodontal disease or broken restorations. The dentist can repair a balanced bite and stop additional damage by making adjustments to these locations.[3]

TMJ disorders

Uneven or excessive bite forces can cause discomfort and dysfunction in patients with TMD.[5] T-scan maps the distribution and sequence of biting forces to identify occlusal inconsistencies that contribute to TMD symptoms. Using this information, dentists can make occlusal changes to improve jaw function and reduce symptoms.[7]

Restorative dentistry

An improperly restored tooth can lead to a number of issues, including headaches, problems associated to TMD, early tooth or restoration fractures, and – most importantly – unbalanced bilateral force application during mastication.[8] T-scan reduced time on restoration completion and follow-up visits by ruling out over- or under-restored teeth.[9]

Prosthodontic rehabilitation

In prosthodontics, maintaining a balanced occlusion is essential to the durability of dentures, crowns, and bridges.[2] Restorations are positioned to complement the patient's natural occlusion thanks to T-scan technology. By confirming that bite pressures are dispersed uniformly throughout restorations, it lowers the possibility of prosthesis failure, discomfort, or injury.[5]

Orthodontics

Sustaining appropriate occlusion is frequently necessary for the stability of post-orthodontic therapy.[7] Following orthodontic treatment, T-scan can assess occlusal connections and detect any high-pressure regions or early contacts that could cause a relapse. Orthodontists can increase the procedure's long-term success by making sure the patient has a balanced bite after treatment.[8]

Oral and maxillofacial surgery

In traffic accidents, mandibular and dentoalveolar fractures are frequent. This results in a slight or significant disoclusion,

which lowers bite forces.[9] The T-scan was found to be the most effective way to assess the accuracy of the new appliance and can be a significant part of the evaluation of occlusion following post-surgical treatment.[6] It also has a significant impact on how accurately the occlusion is determined during orthognathic surgery.[5]

Implantology

Higher bite pressures and excursive stress can cause dental implants to degrade, ultimately resulting in bone loss and implant failure.[4] T-scan displays the force exerted to neighboring teeth and implants at thousands of a second intervals.[7]

Patient education

It covers occlusal diagnosis, equilibration, treatment acceptability, duration, comfort, and the elimination of additional visits. It is simple to inform patients about how their symptoms are impacting their dental health, and they are reassured by the high caliber of care they are receiving.[8] Along with a screen display of the probable cause, the treatment plan's process can also be described.[9]

Post-treatment evaluation

Articulating paper is not a reliable medium since it cannot assess force, balance, or timing. A doctor can confidently and accurately complete a case using T-Scan.[10]

ADVANTAGES OF T-SCAN[5]

- Offers a more thorough and impartial study than conventional techniques, which depend on personal interpretation
- Tracks occlusal forces over time, providing information on bite timing that static techniques are unable to get
- The T-scan's visual output improves communication and treatment compliance by assisting patients in understanding their occlusal problems
- It provides 3D measurements of the position and timing of tooth contact and occlusion
- Shorter duration of treatment
- A decreased chance of porcelain fractures, insecure dentures, damaged teeth, ineffective splints, and implant failure
- It aids in obtaining an accurate diagnosis
- Improved care quality.

LIMITATIONS OF T SCAN[11]

- Uncontrolled mandibular shift has been observed as a result of the foil's insufficient flexibility, leading to inaccurate data
- The sensor film needs to be preconditioned for an accurate recording because its surface does not always exhibit consistent sensitivity
- The sensors have the potential to interfere with and change the occlusion
- More stable contact point data are produced by thinner occlusal registration materials. Dental proprioception may be inhibited by a thick sensor
- When forces are focused over a tiny area, like the cusp of a sharp tooth, the sensors may be harmed. This could produce unreliable results
- The data are not reproducible
- Unable to determine the biting force value in absolute terms.

FUTURE PROSPECTS[12]

The future of T-scan is full with exciting possibilities because technology is always changing:

Integration with 3D imaging

- By combining T-scan data with 3D imaging (cone beam computed tomography or intraoral scans), a thorough digital model of a patient's occlusion might be produced, which would enhance treatment planning.

Artificial intelligence (AI)

- AI could improve T-scan data interpretation by offering predictive insights and facilitating early detection of occlusal issues by physicians.

Improved sensors

- Continuous advancements in sensor technology may result in more robust, accurate, and affordable devices, opening up T-scan to a larger spectrum of dental offices.

CONCLUSION

In the current dental era, the development of sophisticated diagnostic tools such as the T scan computerized occlusal analysis system, which can detect relative occlusal forces accurately in real-time, is a blessing. By providing a dynamic, quantitative approach to evaluating biting force distribution, it has revolutionized the field of occlusal study. It is a useful tool in contemporary dentistry due to its uses in occlusal disease diagnosis, TMD management, and the improvement of orthodontic and restorative procedures. For broader use in clinical settings, its drawbacks – most notably, cost and accessibility – must be overcome.

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