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Review Article

# T scan – A review on an occlusal indicator in dentistry

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ABSTRACT

**Background:** Interdisciplinary science has a focus on occlusion. The intricate operation of the stomatognathic scheme depends on achieving optimal physiological occlusion, which differs from person to person. The maximum intercuspation, maximum biting force, first contact force, and centre of force are all recorded by the T-Scan system. An overview of the system and its dental clinical applications is provided in this review.



## 1. Introduction

Dental occlusion is 'the static relationship between the incisal or masticating surfaces of the maxillary or mandibular teeth or tooth analogues or the act of closure or of being closed or shut off'.[1] Prosthodontics, Oral Surgery, Implantology, Periodontics, Pedodontics, and Endodontics are just a few of the specialities it draws attention from.[2]

The occlusal-articulation relations are recorded using a number of occlusal analysers. In dentistry, articulating paper has become the most used diagnostic technique for locating contacts between the mandibular and maxillary teeth.[3] T-Scan is a development that has lately gained popularity as a dependable and user-friendly clinical diagnostic tool that measures and evaluates occlusal contact force.[4]

Occlusal contacts occur when the mandibular teeth touch the maxillary teeth. Noncontacts are regions wherever there is a separation of 0.5-2 mm between the contacting surfaces of the teeth, while nearby contacts are regions everywhere there is a contact or a breach of 0.5 mm amongst the occluding outsides.[5] The bilateral balanced occlusion, which Bonwill first proposed, is the most well acknowledged occlusal conception currently in use.[1] Any early occlusal acquaintances and articulating obstructions result in occlusal traumas, which lead to modifications in the masticatory muscles, the temporomandibular joint, and the tissues that support the teeth. In order to gauge and estimate the occlusal connection in real time as well as the force of occlusion, a computerised occlusal analysis system called T-scan was developed.[6]

## 2. History of T Scan

T-Scan was created by Tek scan in 1987 and was the first grid-based sensor technology specifically created for occlusal analysis.[4] Maness et al.'s T-Scan® I computerised occlusal examination system debuted the advancement of pressure sensitive ink-Mylar encased sensor technology in 1984. T-Scan, which has been around for more than 25 years, has developed into a decisive analytical gizmo for determining the right occlusal pattern and has enabled high-quality treatment outcomes that were previously impossible.[7]

Based on numerous clinical investigations, the first generation (G1) sensor has undergone numerous design

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revisions and improvements to its registration capacity. The equivalent professional also created T-scan II designed for Windows in 1995, T-scan III (software versions 5, 6, and 7) in 2004, and the high definition (HD) sensor, which is the most recent generation and is far more sensitive and thinner than the previous sensors.[8] Turbo recording was later developed, starting in 2008, and reached its latest iteration in 2014, known as T-scan 8. The T-scan hand piece model had an update in 2015 as T-scan Novus (software version 9.1), with T-scan v10 software version being released in 2018 as the most recent update.[9,10]

## 3. T-Scan Apparatus

### *3.1. Assembly*

A sensor and support, a holder assembly, the system element, computer software, and a laser printer are among the system's components. The U-shaped sensor is housed in the hand-held gadget, which is connected to a computer's USB port and fits into the subject's oral cavity between the occlusal surfaces of their teeth.[3]

By recording factors including bite length, timing, and force of tooth contact, the T-Scan enables the quantification of occlusal contact data. The data is then stored on a hard drive and may be incrementally played for data analysis in a time-based video.[10]

### *3.2. Sensor*

It serves as the primary tool for recording occlusal registration. Occlusal biting forces accurately measured quantitatively by the sensor. It assists in capturing the timing of the occlusal contacts (as a film) and the force that each occlusal contact generates. It is a polyester film that is 60 micrometres thick.[11]

Two sizes of T-Scan sensors are available:[2]

1. Large
2. Small

Small size sensors have 1122 sensels whereas large size sensors have 1370 sensels and can accept arches up to 58 mm wide & 51 mm deep. Large size sensors can accommodate arches up to 66 mm wide & 56 mm deep. The sensor has a 0.1 mm thick.[12]

The first-generation (G1) blue sensor remained prepared of a pressure-sensitive ink grid made of Mylar laminated and shaped like a dental arch. When loaded and inserted intraorally, the relative force information interpreted 16 levels of intraoral force in time increments of 0.01 seconds. The second-generation (G2) T-Scan sensor was more pliable and thinner.[13] For use in the third generation (G3) of T-Scan sensors, which were created in combination by the T-Scan II, Tek scan created its own exclusive resistive ink. The hysteresis, gist & repeatability of the sensor were all intended to be enhanced by this new ink. It was made up of two coatings of Mylar that were sandwiched together by a lattice of resistive inked rows & columns that had been screen-printed.[14]

The ultra-thin (0.004-inch, 0.1-mm), reusable sensor used by T-scan III v10 is tailored to accommodate the dental arch. The HD sensor's structural design comprises of two coats of Mylar that are sandwiched together by a printed lattice of resistive ink rows and columns.[12] To reliably register absolute bite forces, the T-Scan sensors must be calibrated. A trustworthy calibration would enable converting the output of the 'T-Scan sensor' through biting in hominid test participants into absolute force units.[8]

#### *3.2.1. Mechanism*

The sensor is fastened to a handle that scans at intervals of one thousandth of a second. The system can be activated on two modes, time analysis and force analysis.[3,15]

1. Time analysis: This option displays the first, second, and/or subsequent occlusal contacts in a distinct colour to provide information on their location and order. The timing of each subsequent interaction in relation to the initial contact is shown at the top of the monitor screen.
2. Force analysis: Data about the position and relative force of tooth contact are provided to the operator in this mode. The screen's bottom displays the bite length.

Various functional mandibular motions are recorded in clinical settings using the T-scan 8 technology:[4]

1. Centric relation: This indicates the immaturity of the centred relation.
2. Multi-bite: This archives two or more repetitive self-closures prepared in patient's habitual intercuspation.
3. Excursive functional movements – lateral and protrusive: The posterior disclusion time (DT) that happens during mandibular excursions is measured using this recording.
4. Clenching and grinding: This documents uncomfortable chewing and eating encounters.
5. Digital occlusal force distribution patterns: This keeps track of excessive concentrations of occlusal force in the arch.

#### *3.2.2. Applications*[2,16]

1. Root Recession Defects and Abfraction Formation
2. Cosmetic Restorations
3. Adhesive and Artistic Prostheses
4. Full mouth reconstruction
5. Implant Prosthodontics and natural tooth occlusion function
6. Orthodontics
7. Prosthodontics
8. Splint/orthodontic therapy, and
9. Temporomandibular disorders.

### 3.3. Advantages[15,17]

1. Lessened risk of implant failure, damaged teeth, unstable dentures, ineffective splints, and porcelain fractures.
2. Legal documentation of outcome.
3. Enhanced patient education.
4. Building your practise.
5. Increased referral business from other doctors.
6. Improved diagnosis.
7. Increased quality of care.
8. Decreased treatment time and Increased comfort of dental prosthetics.

### 3.4. In restorative dentistry and prosthodontics

Occlusal incongruities are unique of the most harmful functional issues experienced following treatment in prosthodontic rehabilitation.[18] Therefore, it is crucial to use a permanent restoration to create an occlusion that is both mechanically and physiologically sound. Numerous occlusal analysers are used in dentistry to record the occlusal-articulation relation. These occlusal analysers can be broadly classified as gauges, both quantitative and qualitative.[19]

Halili R et al.,[20] conducted an electronic search using Google Scholar, PubMed, MEDLINE, and Web of Science. A number of studies revealed that the T-Scan computerised occlusal analysis be able to afford measureable occlusal load and timing statistics that will allow for better protection of brittle dental ceramic and, most importantly, an improvement in the comfort and function of the patient's bite.

Bozhkova T P et al.,[6] explained that by revolving qualitative data into assessable information and digitally showing it, the T-SCAN technology offers the only precise method of determining and evaluating the timing and force of occlusal interactions. Using the T Scan III technology, Vladutu DE et al.,[21] analysed the occlusal connections in students who grind their teeth and found a positive link between these relationships and the activity of the mastication muscles as measured by surface electromyography.

### 3.5. Implant dentistry

Due to its durability, high patient satisfaction, predictable aftereffects, and minimum harm to surrounding tissues, dental implant repair is among the top treatment substitutes for supplanting absent teeth, especially free-ends. Occlusion is the foundation of masticatory purpose and a crucial sign of oral implant restoration success that can be determined by T Scan.[22]

In their work, Wu ML et al.,[23] used the T-SCAN III scanner to gather dynamic quantitative data prior to and following the renovation of free-end implants and to investigate how the T-SCAN III may be used to redistribute the occlusal force of free-end implants. Using a computerised occlusal analysis system, Ding Q et al.,[24] examined the longitudinal change of occlusal strength dissemination and occlusal connexion interval in posterior implant-supported single crowns.

### 3.6. In orthodontics

The lack or presence of asymmetric connections can point to the necessity for additional finishing and correction in orthodontics. The T-Scan system is used to compare the symmetry of the occlusal force before and after treatment as well as to trace and locate traumatic occlusal contacts. The T-Scan device can also be a helpful tool for monitoring patients and determining whether a relapse has occurred.[25,26]

F Fritz et al.,[27] assessed the comparative dispersal of occlusal loads after orthodontic management and throughout the initial 3 months of the retention stage using a high-tech occlusal exploration co-ordination. The goal of the last phase should be an equitable distribution of occlusal loads because T Scan did not show any qualified benefits for any retention plan in terms of post-debond improvement throughout the retention phase. Chaikla K et al.,[28] employing the T-Scan III system, it was possible to assess and compare the initial tooth interaction region, occlusion time, time to create total force, and strength dispersal between patients with open bites and those who weren't, at the maximum intercuspation position..

### 3.7. In orthognathic surgery

The intricate operation of the stomatognathic system depends on the optimal physiological occlusion being achieved following osteotomy. Dental occlusion differs from person to person. The T-Scan system logs the bite force maximum, first contact, and maximum intercuspation.[26]

The efficacy and reliability of T-Scan in evaluating occlusion previously and afterward orthognathic surgery were examined by Agbaje JO et al.,[29] in 40 individuals undergoing orthognathic surgery and 30 hale and hearty adults through typical occlusion had their occlusal information examined. When designing a course of therapy and monitoring its effectiveness, T-Scan can be utilised to show the distribution of occlusal contacts before and after surgery. By means of T-Scan III System precise analysis, Trpevska V et al.,[30] examined the occlusal force and occlusal contacts distribution over time in patients with neutroocclusion.

### 3.8. In pedodontics

Some of the digital dental technologies now on the market have been shown to be helpful in paediatric dentistry. One such cutting-edge computerised analyzer that is quite

helpful for youngsters to check for occlusal discrepancies is the T Scan.[31] The repeatability and clinical presentation of the T-Scan system in children were discussed by K. Okamoto et al.,[32,33] In order to ascertain whether the extreme intercuspation locus in children is affected by the installation of an SSC, whether it returns to normal after 4 weeks, and whether local anaesthesia affects the child's capacity to reach MIP, Gallangher S et al.[34] Occlusal contacts were measured using the T-Scan III.

### *3.9. In periodontics*

The periodontium has the capacity to bear the pressure that the tooth applies during occlusal contact. The main causes of changes in tooth occlusion are early interactions or interferences. The occurrence, degree, interval, and path of occlusal compressions all have an influence on the periodontium. The occlusal status of a person is primarily described by two key traits. They are (a) intra-architectural relationship and (b) inter-architectural relationship.[2]

Deepika BA et al.,[35] figured out if periodontal therapy calls for occlusal modification. The T-scan approach is unquestionably a suitable means for assessing and evaluating the occlusal contacts during maximal intercuspation, it was also concluded.

Saravanan R[36] investigated the effects of elevated occlusal force on the severity of periodontal disease and the effects of occlusal correction based on T-Scan evaluation on healing following periodontal therapy. The findings showed a strong correlation between occlusal force and the severity of periodontitis. Occlusal correction reduced periodontal parameters, however this correlation was not statistically significant.

Sreelakshmi CK et al.,[37] using T-Scan III, it was determined how occlusal loading forces, occlusal contact variability, and their correction were managed in cases of periodontitis.

### *3.10. In temporomandibular joint disorders*

Chronic Disclusion Time, occlusal interferences, and occlusal surface friction have all contributed to the symptoms of Temporomandibular Disorder (TMD) in hyperactive masticatory muscles.[12] TMD has a complex aetiology. Occlusion is thought to be a key factor in the beginning of a condition, however this hasn't been shown beyond a reasonable doubt. There is ongoing debate on the part of occlusion as causative influence for TMD. Disclusion The T-Scan can reduce the amount of time spent in TMDs.[17]

The T-scan method offers information on functional occlusion and allows the physician to objectively assess the occlusal contacts during continuous mandibular movement. In the realm of TMDs, the T scan I technology (Tscan 2000; Tekscan Inc.) was first released in 1984 and cleared the way for studies that were backed by research that showed dental occlusion as an causative element for TMD. A new occlusal functional movement parameter to assess prolonged excursive movement durations was developed because the T-scan I could measure occlusal contact time sequences in 0.01 s increments.[38]

Thumati P et al.,[26] on 100 patients, the ICAGD technique was used to assess the impact of occlusal equilibration on the patients' subjective myofascial pain symptoms. The reduction of the anterior DT to 0.4s was the main goal, and the symptoms and indicators of myofascial pain were the secondary goals. Dzingute et al.,[39] employing the T-scan II computerised occlusal analysis system on 44 TMD patients. The patient's occlusion as well as static occlusal data such the OT, asymmetry index of maximal occlusal force, and centre of occlusal force were noted. The findings indicated a connection between static occlusion factors and TMD.

## 4. Limitations of the T-Scan System:[4,9]

1. Thinner occlusal registration materials have been shown to produce more reliable records of the contact locations. The T-Scan sensors are as tiny as feasible (0.1mm) to meet the technological requirements. These sensors are still somewhat thicker than occlusal pointers like articulating silk, though. This could have a substantial impact on the functional occlusion and potentially change how the masticatory muscles work.
2. It has been demonstrated that all occlusal registration items can alter the occlusion, thus clinicians should be mindful of these restrictions when making functional occlusion changes. Additionally, when stresses are focused in a limited region, like a sharp tooth cusp, the sensors may be harmed. This is caused by increasing bite forces that were previously quite mild but were concentrated and produced strong pressure in a confined location. Additionally, this could result in erroneous recording of the occlusal contact and/or artefacts in the photographs that are created. The T Scan device can only recreate occlusal interferences with dimensions more than 0.6mm.
3. Additionally, the system's two distinct modes (the force and time analysis modes) may yield various occlusal contact data.

## 5. Conclusion

The advancement of technology has piloted in a new era in medicine. Occlusion understanding is crucial for successful clinical dentistry practise. The T Scan system touts its ease of use, vibrant inspecting of occlusion, planned force analysis at several locations of teeth contact, and the potential for permanent documentation and monitoring of the occlusal condition following the completion of various treatment procedures.

## 6. Author's Contribution

1. Concept, design, definition of intellectual content – Dr. Sowmya Gujjar Vishnurao
2. Literature search – Dr. Ashish Aggarwal, Dr. Sowmya Gujjar Vishnurao
3. Data acquisition, data analysis – Dr. Sowmya Gujjar Vishnurao
4. Manuscript preparation, manuscript editing and manuscript review – Dr. Madhusudan Astekar, Dr. Sowmya Gujjar Vishnurao

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None.

## 8. Conflict of Interest

None.

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