

ROLE OF T-SCAN IN DENTISTRY - A REVIEW

Sarojini Ramya Pillay

*Saveetha Dental College and Hospitals Saveetha Institute of Medical and Technical Sciences
Saveetha University Chennai, India. Email id: 151601058.sdc@saveetha.com*

Dr. Sanjana Devi N

*Assistant Professor Department of Prosthodontics and Implantology Saveetha Dental College and
Hospitals Saveetha Institute of Medical and Technical Sciences Saveetha University
Chennai, India. Email id: sanjanadevin.sdc@saveetha.com*

Dr. Deepak Nallaswamy Veeraiyan

*Professor and Director of Academics Department of Prosthodontics Saveetha Dental College
and Hospitals Saveetha Institute of Medical and Technical Sciences Saveetha University
Chennai, India*

ABSTRACT

Background: Occlusion analysis is essential for determining any occlusal disharmony. The complexity of the human occlusal system, it was extremely difficult to analyze challenges with occlusal origins. The demand for the least traumatic dental occlusion is increasing, which led to the development of T-scan. It assesses occlusion both qualitatively and quantitatively. Instead of the previous messy qualitative carbon marks, it is presented in video format. The platform allows for dynamic viewing of occlusion, timed analysis of force during various positions of teeth contact, and the possibility of permanent documentation and monitoring of the occlusal condition after completing the various treatment protocols. The T-Scan is a useful tool for clinical evaluation and understanding of occlusal problems. The goal of this review paper is to provide an overview of the system as well as its application in advanced methods of treatment.

Keywords: T scan, occlusal, generation, technology

INTRODUCTION

As per the Prosthodontics Glossary (2005), Occlusion is "the static relationship between the incising or occlusal surfaces of the maxillary or mandibular teeth or tooth analogues. The occlusion should be stable and as stress free as possible (1). When mandibular teeth make contact with maxillary teeth, occlusal contacts are established. Contacts in close proximity are those regions that have a contact to a gap of 0.5 mm between the occluding surfaces, whereas non-contacts are those which do not have a contact, those areas where the teeth are separated by 0.5-2 mm ((2). The bilateral balanced occlusion proposed by Bonwill is the most widely accepted of the numerous different occlusal concepts. Occlusal contact marking indicators are used to determine the actual location of occlusal contacts. These indicators are made of different materials that, upon occlusal contact, transfer color from the indicator to the occlusal contact area. The T-Scan system is an automated dental device that can analyze occlusal contacts quantitatively (3). According to the description, the true occlusal contact time is 0 s between the first and last occlusal contact. Occlusal therapy aims to achieve this occlusal contact relationship

simultaneously. The T-scan occlusal analysis system is one method for evaluating occlusal forces (4). This review of T-scan technology will help in various aspects in the dentistry field and multidisciplinary approach to providing better patient care and quality of work. Our team has extensive knowledge and research experience that has translated into high quality publications(5–24).

HISTORY OF T SCAN

T-Scan, the first grid-based sensor technology specifically designed for occlusal analysis, was developed by Tekscan in 1987. Tekscan established this powerful diagnostic tool in response to dentists' need for an accurate way to dynamically measure occlusion (25). Maness et al. introduced the T-Scan® I computerized occlusal analysis system in 1984, which marked the start of the evolution of pressure sensitive ink - Mylar encased sensor technology. In 1987, Tekscan developed T-Scan®, the first ever grid-based sensor technology specifically designed for occlusal analysis. The advancement has now reached the t-scan version (3).

T-Scan computerized occlusal analysis (Tekscan, Boston, USA) is an essential component of clinical functional analyses in prosthetic and restorative placements. The T-Scan computerized system can quickly identify prematurities, high points, regions of excessive force, and non-uniform force concentration(26). It can also precisely calculate disocclusion time. Maness et al. introduced pressure sensitive ink - Mylar encased sensor technology in 1984 with the T-Scan® I computerized occlusal analysis system (27). T-Scan®, the first grid-based sensor technology specifically designed for occlusal analysis, was developed by Tekscan in 1987. T-scan is the most recent advancement till date.

PARTS OF T SCAN SYSTEM

T-Scan is an occlusal force analysis device that is computerized. It is an important component of clinical functional analyses in prosthetic and restorative insertions (28). Prematurity, high points, regions of excessive force, but also non-uniform force concentration can all be determined quickly using the T-Scan computerized system. It can also precisely evaluate disocclusion time. Maness et al. introduced the T-Scan I computerized occlusal analysis system in 1984, that also showcased the evolution of pressure sensitive ink - Mylar encased sensing technologies (29).

It is divided into three sections. A thin (75 micron) sensor is bit by the patient. The sensor is made up of pressure sensitive ink columns and rows trapped in a Mylar sandwich. This scans at thousandth-of-a-second intervals. The handle reads data from the sensor and sends it to computer software, which displays it in an easy-to-understand visual display.

SENSOR

T-Scan sensors are available in two sizes, large and small. The large sensor can accommodate arch up to 66 mm wide and 56 mm deep and has 1370 sensels, whereas the small sensor can accommodate arch up to 58 mm wide and 51 mm deep and has 1122 sensels. The sensor has a thickness of 0.1 mm³ (30).

Two Mylar layers Dielectric Electronic Leads with 2200 sensing points and a sensor thickness of 100 microns. Re-used for at about -15 to 25 recordings (31). The recording handle with the sensor and arch support is placed between the patient's maxillary central incisors. Pressing the button on the recording handle starts the recording. The patient is instructed to keep the mouth closed until complete intercuspation is achieved, without making any excursive movements.

The recorded data is shown as a force movie in which the middle of force trajectory shows the history of the path of the middle of force from the beginning of the force movie recording to the current displayed frame (32). When more of the patient's teeth come into contact sequentially, the trajectory movement indicates where the force summation is directed.

The system has two modes of operation: time analysis and force analysis.

Time analysis: This mode provides information on the location and sequence of occlusal contacts, highlighting the first, second, and third or more contacts in a different color ((33). The timing of each subsequent contact in relation to the first is displayed at the top of the monitor screen.

Force analysis: This mode provides the operator with information on the location and relative force of tooth contact. Bite length can be read at the bottom of the screen.

The recorded data is displayed as a force film and is displayed as a force film with the center of force trajectory displaying the history of the path of the center of force from the start of the force movie recording to the current displayed frame (34).

USES OF T SCAN

Application of T-scan is seen in : Fixed & Removable Prosthetics , Implant Prosthetics ,TMD Appliances, Occlusal Equilibration, Disclusion Time Reduction, Abfraction Management, Periodontal Management, Differential Diagnosis, Orthodontics, Locating Painful Teeth and Dental Case Finishing (35–37).

PROS AND CONS OF T SCAN

The advantages of using a T scan is as follows enhanced overall diagnosis, improved care quality, the treatment time has been reduced. Increased dental prosthesis comfort. Implant failure, damaged teeth, insecure dentures, ineffective splints, and porcelain fractures are all reduced (38). The outcome is legally documented. Improved patient education while using T scan. Set backs of T scans are Thinner occlusal registration materials enable more stable contact point records. To meet technological demands, T-Scan sensors are designed as small as possible (0.1mm), although they are still considerably bulkier than occlusal indicators such as articulating silk. Moreover when stresses are focused over a tiny area, such as a sharp tooth cusp, the sensors may be damaged. This may result in an inaccurate recording of the occlusal contact and/or artefacts in the photographs produced. The T-Scan device can mimic occlusal interferences with dimensions no larger than 0.6mm. In addition, the system's two opposing modes (force and time analysis modes) may replicate different occlusal contact data. Time mode has been shown to record the most contacts, whilst force mode has been shown to record the least volatility.

APPLICATION OF T SCAN

T-scan is used in the following areas: fixed and removable prosthetics, implant prosthetics, TMD Appliances, Occlusal Equilibration, Disclusion Time Reduction, Abfraction Management, Periodontal Management, Differential Diagnosis, Orthodontics, Locating Painful Teeth, and Dental Case Finishing (39). In case finishing the single unit fillings to full mouth rehabilitation, a balanced occlusion with mutual anterior/posterior protection is critical for patient satisfaction and restoration lifetime (40). Because articulating paper does not quantify force, balance, or timing, it is insufficiently sophisticated

to be relied on. T-Scan enables a doctor to complete a case with accuracy and confidence. For diagnostic screening the occlusal trauma is the root cause of many oral disorders. Abfractions, bone loss, exostosis, periodontal pocketing, cusp breakages, (41) restorative failure, and excessive wear are all possible. It is critical for accurate diagnosis to measure the force and time of a functional bite. Implants in periodontal sockets do not flex (42). Controlling the force on a restored implant prosthesis is challenging enough without going "blind" by failing to measure it at all. The T-Scan measures the force exerted to neighboring teeth and implants in thousands of millisecond time intervals. Case completion in cosmetic dentistry can mean the difference between a successful and unsuccessful case. Because of the precise nature of cosmetically oriented patients, knowing that the restorations will be functional and veneers will not de-bond is a huge value (43).

CONCLUSION

T-scan is available in several versions, including T scan I, T scan II, T scan III, T scan IV, T scan V, and the most recent, VI (44). T-scan data can be analyzed in three different ways. One is that it displays the duration and magnitude of all tooth interactions and also detects disproportional loading forces and transitory impact forces on specific teeth. It also detects active tooth contact throughout the functional range of mandibular movement, as well as the interaction of working and non working interferences.

The T-Scan technology has proven to be a trustworthy method for analyzing and evaluating occlusal contact distribution in maximal intercuspation. Despite its high cost, it is a valuable method for clinical examination and comprehension of occlusal issues, as well as a significant teaching tool.

REFERENCES

1. Viram U, Arora A, Kapur DS, Anika K. T-Scan: occlusion demystified. *Unique Journal of Medical and Dental Sciences*. 2015;3(1):1–5.
2. Metwally A. Comparison Of Patient Satisfaction & Occlusal Force Distribution pattern In CAD/CAM and conventional Complete Dentures Using The T-Scan III Computerized Occlusal Analysis System. (RCT) [Internet]. Vol. 65, *Egyptian Dental Journal*. 2019. p. 2641–9. Available from: <http://dx.doi.org/10.21608/edj.2019.72627>
3. Balos MD, Soaita C, Cerghizan D, Popsor S. A Study on the Mandibular Arc of Closure Reproducibility Using the T-Scan III Computerized Occlusal Analysis System [Internet]. Vol. 19, *Procedia Technology*. 2015. p. 916–20. Available from: <http://dx.doi.org/10.1016/j.protcy.2015.02.131>
4. Chapman RJ, Kirsch A. Variations in occlusal forces with a resilient internal implant shock absorber. *Int J Oral Maxillofac Implants*. 1990 Winter;5(4):369–74.
5. Sekar D, Auxzilia PK. Letter to the Editor: H19 Promotes HCC Bone Metastasis by Reducing Osteoprotegerin Expression in a PPP1CA/p38MAPK-Dependent Manner and Sponging miR-200b-3p [Internet]. Vol. 74, *Hepatology*. 2021. p. 1713–1713. Available from: <http://dx.doi.org/10.1002/hep.31719>
6. Vignesh R, Sharmin D, Rekha CV, Annamalai S, Baghkomeh PN. Management of Complicated Crown-Root Fracture by Extra-Oral Fragment Reattachment and Intentional Reimplantation with 2 Years Review. *Contemp Clin Dent*. 2019 Apr;10(2):397–401.
7. Rajagopal R, Padmanabhan S, Gnanamani J. A comparison of shear bond strength and debonding characteristics of conventional, moisture-insensitive, and self-etching primers in vitro. *Angle Orthod*. 2004 Apr;74(2):264–8.

8. Happy A, Soumya M, Venkat Kumar S, Rajeshkumar S, Sheba RD, Lakshmi T, et al. Phyto-assisted synthesis of zinc oxide nanoparticles using *Cassia alata* and its antibacterial activity against *Escherichia coli*. *Biochem Biophys Rep*. 2019 Mar;17:208–11.
9. Neelakantan P, Sharma S, Shemesh H, Wesselink PR. Influence of Irrigation Sequence on the Adhesion of Root Canal Sealers to Dentin: A Fourier Transform Infrared Spectroscopy and Push-out Bond Strength Analysis. *J Endod*. 2015 Jul;41(7):1108–11.
10. Teja KV, Ramesh S. Is a filled lateral canal - A sign of superiority? *J Dent Sci*. 2020 Dec;15(4):562–3.
11. Jose J, P. A, Subbaiyan H. Different Treatment Modalities followed by Dental Practitioners for Ellis Class 2 Fracture – A Questionnaire-based Survey [Internet]. Vol. 14, *The Open Dentistry Journal*. 2020. p. 59–65. Available from: <http://dx.doi.org/10.2174/1874210602014010059>
12. Patil SB, Durairaj D, Suresh Kumar G, Karthikeyan D, Pradeep D. Comparison of Extended Nasolabial Flap Versus Buccal Fat Pad Graft in the Surgical Management of Oral Submucous Fibrosis: A Prospective Pilot Study [Internet]. Vol. 16, *Journal of Maxillofacial and Oral Surgery*. 2017. p. 312–21. Available from: <http://dx.doi.org/10.1007/s12663-016-0975-6>
13. Marofi F, Motavalli R, Safonov VA, Thangavelu L, Yumashev AV, Alexander M, et al. CAR T cells in solid tumors: challenges and opportunities. *Stem Cell Res Ther*. 2021 Jan 25;12(1):81.
14. Prasad SV, Vishnu Prasad S, Kumar M, Ramakrishnan M, Ravikumar D. Report on oral health status and treatment needs of 5-15 years old children with sensory deficits in Chennai, India [Internet]. Vol. 38, *Special Care in Dentistry*. 2018. p. 58–9. Available from: <http://dx.doi.org/10.1111/scd.12267>
15. Aparna J, Maiti S, Jessy P. Polyether ether ketone - As an alternative biomaterial for Metal Richmond crown-3-dimensional finite element analysis. *J Conserv Dent*. 2021 Nov;24(6):553–7.
16. Kushali R, Maiti S, Girija SAS, Jessy P. Evaluation of Microbial Leakage at Implant Abutment Interfact for Different Implant Systems: An In Vitro Study. *J Long Term Eff Med Implants*. 2022;32(2):87–93.
17. Ponnanna AA, Maiti S, Rai N, Jessy P. Three-dimensional-Printed Malo Bridge: Digital Fixed Prosthesis for the Partially Edentulous Maxilla. *Contemp Clin Dent*. 2021 Oct;12(4):451–3.
18. Kasabwala H, Maiti S, Ashok V, Sashank K. Data on dental bite materials with stability and displacement under load. *Bioinformation*. 2020 Dec 31;16(12):1145–51.
19. Agarwal S, Maiti S, Ashok V. Correlation of soft tissue biotype with pink aesthetic score in single full veneer crown. *Bioinformation*. 2020 Dec 31;16(12):1139–44.
20. Merchant A, Maiti S, Ashok V, Ganapathy DM. Comparative analysis of different impression techniques in relation to single tooth impression. *Bioinformation*. 2020 Dec 31;16(12):1105–10.
21. Agarwal S, Ashok V, Maiti S. Open- or Closed-Tray Impression Technique in Implant Prosthesis: A Dentist's Perspective. *J Long Term Eff Med Implants*. 2020;30(3):193–8.
22. Rupawat D, Maiti S, Nallaswamy D, Sivaswamy V. Aesthetic Outcome of Implants in the Anterior Zone after Socket Preservation and Conventional Implant Placement: A Retrospective Study. *J Long Term Eff Med Implants*. 2020;30(4):233–9.
23. Merchant A, Ganapathy DM, Maiti S. Effectiveness of local and topical anesthesia during gingival retraction [Internet]. Vol. 25, *Brazilian Dental Science*. 2022. p. e2591. Available from: <http://dx.doi.org/10.4322/bds.2022.e2591>
24. Agarwal S, Maiti S, Subhashree R. Acceptance Towards Smile Makeover Based on Spa Factor- A Myth or Reality [Internet]. Vol. 11, *International Journal of Research in Pharmaceutical Sciences*. 2020. p. 1227–32. Available from: <http://dx.doi.org/10.26452/ijrps.v11ispl3.3369>

25. Pyakurel U, Long H, Jian F, Sun J, Zhu Y, Jha H, et al. Mechanism, accuracy and application of T-Scan system in dentistry-A review. *J Nepal Dent Assoc.* 2013;13(1):52–6.
26. Cartagena AG, Sequeros OG, Garcia VCG. Analysis of two methods for occlusal contact registration with the T-Scan system. *J Oral Rehabil.* 2008 Jun 28;24(6):426–32.
27. Lyons MF, Sharkey SW, Lamey PJ. An evaluation of the T-Scan computerised occlusal analysis system. *Int J Prosthodont.* 1992 Mar;5(2):166–72.
28. Kalachev Y. Occlusal pressure and strain in the periodontium--analysis and recommendations for clinical use [dissertation] Faculty of Dental Medicine. Medical University, Plovdiv. 2003;
29. Long H, Zhou Y, Pyakurel U, Liao L, Jian F, Xue J, et al. Comparison of adverse effects between lingual and labial orthodontic treatment: A systematic review [Internet]. Vol. 83, *The Angle Orthodontist.* 2013. p. 1066–73. Available from: <http://dx.doi.org/10.2319/010113-2.1>
30. Kerstein RB, Thumati P, Padmaja S. Force Finishing and Centering to Balance a Removable Complete Denture Prosthesis Using the T-Scan III Computerized Occlusal Analysis System. *J Indian Prosthodont Soc.* 2013 Sep;13(3):184–8.
31. Koos B, Godt A, Schille C, Göz G. Precision of an instrumentation-based method of analyzing occlusion and its resulting distribution of forces in the dental arch. *J Orofac Orthop.* 2010 Nov;71(6):403–10.
32. Agbaje JO, Van de Castele E, Salem AS, Anumendem D, Shaheen E, Sun Y, et al. Assessment of occlusion with the T-Scan system in patients undergoing orthognathic surgery [Internet]. Vol. 7, *Scientific Reports.* 2017. Available from: <http://dx.doi.org/10.1038/s41598-017-05788-x>
33. Wiczorek A, Loster J, Loster BW. Relationship between occlusal force distribution and the activity of masseter and anterior temporalis muscles in asymptomatic young adults. *Biomed Res Int.* 2013;2013:354017.
34. Dmd RBK, Kerstein RB, D. History of the T-Scan System Development from 1984 to the Present Day [Internet]. *Handbook of Research on Computerized Occlusal Analysis Technology Applications in Dental Medicine.* 2015. p. 1–35. Available from: <http://dx.doi.org/10.4018/978-1-4666-6587-3.ch001>
35. Kerstein RB. T-scan III applications in mixed arch and complete arch, implant -supported prosthodontics. *Dent Implantol Update.* 2008 Jul;19(7):49–53.
36. Montgomery MW, Shuman L, Morgan A. T-scan dental force analysis for routine dental examination. *Dent Today.* 2011 Jul;30(7):112–4, 116.
37. Trpevska V, Kovacevska G, Benedeti A, Jordanov B. T-scan III system diagnostic tool for digital occlusal analysis in orthodontics - a modern approach. *Pril (Makedon Akad Nauk Umet Odd Med Nauki).* 2014;35(2):155–60.
38. Wang YL, Cheng J, Chen YM, Yip KHK, Smales RJ, Yin XM. Patterns and forces of occlusal contacts during lateral excursions recorded by the T-Scan II system in young Chinese adults with normal occlusions. *J Oral Rehabil.* 2011 Aug;38(8):571–8.
39. Kerstein RB. Current applications of computerized occlusal analysis in dental medicine. *Gen Dent.* 2001 Sep;49(5):521–30.
40. Kerstein RB, Lowe M, Harty M, Radke J. A force reproduction analysis of two recording sensors of a computerized occlusal analysis system. *Cranio.* 2006 Jan;24(1):15–24.
41. Garg AK. Analyzing dental occlusion for implants: Tekscan's TScan III. *Dent Implantol Update.* 2007 Sep;18(9):65–70.
42. Kalachev IS. Evaluation of the T-scan system in achieving functional masticatory balance. *Folia Med .* 2005;47(1):53–7.

43. Afrashtehfar KI, Qadeer S. Computerized occlusal analysis as an alternative occlusal indicator. *Cranio*. 2016 Jan;34(1):52–7.
44. Dees A, Kess K, Proff P, Schneider S. The use of the T-Scan system in occlusal diagnosis. *Dtsch Zahn Mund Kieferheilkd Zentralbl*. 1992;80(3):145–51.