Clinical Significance And Application Of The T Scan III System For Occlusal Evaluation In Prosthodontics: A Review

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Abstract:
Background: The aim of this review paper is to determine the mechanism, methodology, clinical application and capabilities of the T-Scan III Evolution system, as well as its role as a diagnostic tool for digital occlusal analysis in various fields of dentistry, especially in removable dental prosthetics.
Materials and Methods: ResearchGate and PubMed databases were searched in order to achieve the aim. Scientific papers and publications were selected that addressed the issues of interest for this research. Several reference lists of authors who have used digital occlusal analysis in their research have been identified.
Results: According to the literature database, 11 papers were selected and elaborated, which used the T-Scan III Evolution system for digital occlusal analysis in removable dental prosthetics. Digital occlusal analysis has a significant advantage over other means of occlusal analysis, in terms of its ability to measure occlusal parameters (occlusion time and force of occlusal contacts), during both static and dynamic position of the mandible.
Conclusion: We can conclude that the T-Scan III Evolution system is a computerized method for occlusal analysis of the dentition, which in a very fast, reliable and accurate way shows the distribution of occlusal forces. In fact, the method is exact in identifying the time of the occlusal contacts as well as the strength of the occlusal contacts. Additional clinical studies are needed in order to expand the application of this system. Its use in trials in the field of dental prosthetics is especially important.
Key Word: prosthodontic therapy, removable dentures, T-Scan III Evolution system, occlusal analysis
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Date of Submission: 29-10-2023   Date of Acceptance: 09-11-2023

I.   Introduction

The occlusion and articulation of the natural and artificial teeth is an unavoidable topic in all areas of dentistry - orthodontics, mobile and fixed dental prosthetics, implantology, oral and maxillofacial surgery, periodontology, pedodontics, and oral pathology. In order to diagnose occlusal irregularities, it is essential to have an objective knowledge of the occlusion and articulation of the teeth, but also to have a method that will allow the dentist to analyze.

The development of the occlusal analysis methodology goes through different phases at different times. In the beginning, the technique of visual evaluation and a test that examines the teeth for mobility and vibration of the tooth when it goes into contact with another tooth (so-called fremitus) were used, in order to rule out occlusal pathology. However, other methods have evolved over time, such as the measuring of occlusal features with millimeter rulers, testing occlusal contacts with articulation paper or occlusal wax, registering occlusal contacts with silicones, mapping occlusion with an occlusal sketch, photographs, and using occlusal sonography.

In 1987, a prototype of a new device for computerized occlusal analysis was presented, the so-called T-Scan system. Historically, over a period of 25 years, the T-Scan system has evolved starting from the earliest system T-Scan I through T-Scan II to T-Scan III Evolution. In fact, the entire system has undergone massive hardware, sensor and software revisions to arrive at the latest version (version 7.0) which is a vast improvement over the earliest T-Scan I system.

The T-Scan III Evolution system enables a precise digital occlusal analysis of natural and artificial teeth, i.e. measurement of occlusal forces during maximum intercuspation and during articulation movements of the jaws. In fact, this device allows a qualitative and quantitative analysis of occlusal forces shown in the form

of a video recording. Normal occlusal and articulating relationships ensure equal distribution of masticatory forces during the act of mastication.

In recent decades, the T-Scan has been used in the field of dentistry in various disciplines: analysis of natural dentition, premature contacts; occlusal balance, fixed and mobile dental prosthetics, implantology, orthodontics, TMD appliances; periodontal diseases, locating painful teeth. This is also shown by the following review of the literature.

The aim of this review paper is to determine the mechanism, methodology, clinical application and capabilities of the T-Scan III Evolution system, as well as its role as a diagnostic tool for digital occlusal analysis in various areas of dentistry, especially in mobile dental prosthetics.

II. Material And Methods

To achieve the aim, a search was performed of the electronic databases ResearchGate and PubMed. Scientific papers and publications that dealt with the issue of interest for this research were selected. Several reference lists of authors who used digital occlusal analysis in their research were identified.

The T-Scan III Evolution has two modes of operation: time analysis and force analysis. Time analysis provides information on a sequence of occlusal contact locations, displaying them in different colors. Simultaneously, the time frame of each subsequent contact in relation to the first one is displayed on the upper part of the screen.

With the force analysis, data is obtained about the location of the bite force of the teeth in the dental arch as well as the intensity of the force during occlusal contacts. The length of the bite is also given at the bottom of the screen. During the force analysis, two additional options are possible: registration of the current position of the mandible, and registration of the contact intensity during the movement of the mandible.

III. Result

Bozhkova TP. in her research, uses the T-Scan III Evolution system for measuring and assessing the forces of occlusal contacts and their evaluation. The tests were carried out on 30 students aged 19 to 22 years, who have intact dentition and jaw ratio of Class I according to Angle. The obtained results showed that the time sequence and strength of occlusal contacts were precisely determined and evaluated, by converting the qualitative data into quantitative data and displaying it digitally [1,2].

Also, Ibraheem, E.M., ElGabry, H.S., were examining the distribution of different occlusal forces, using T-Scan, in order to evaluate the effect of relining total dentures with soft acrylate. For this study, 50 patients wearing conventional total dentures were selected. The patients had controlled diabetes mellitus, and their residual alveolar ridge was moderately maintained and lined with solid mucoperiosteum. Relining of the lower total prostheses with soft acrylate was performed in these subjects. The measurement of the distribution of the occlusal forces was done before they were relined and three months after the relining. The obtained results showed that the use of soft acrylate for relining the lower total prosthesis significantly improves the distribution of occlusal forces [3].

Kürklüarpacay, D., Bayindir, F. and Dinçkalyanikoğlu, N., were aiming to evaluate the premature contacts and occlusal forces of each tooth in total dentures, before occlusal adjustment. The examined group consisted of 30 subjects between the ages of 50 and 75, and T-Scan was used for the examination. The subjects were tested before and after occlusal adjustment of their total dentures. The results showed the presence of premature contacts with a large difference in the values of the occlusal forces. After occlusal adjustment, they observed a balancing of the percentage values of the occlusal forces. They concluded that occlusal adjustment is necessary in all total prostheses in order to prevent muscle pain and TMJ disorders [4].

In 2018, El Homossany, M., Abdallah, H. in their study, aimed to compare the occlusal force values between conventional total dentures and implant-supported overdentures. Computerized occlusal analysis using T-Scan was used as a method. This study was conducted in 50 patients and the mean value was calculated for each of them. The results showed that conventional total dentures had a time sequence longer by 0.13 seconds compared to implant-supported overdentures. In conclusion, they state that implant-supported overdentures proved to be a better treatment option in terms of occlusion time and disocclusion time because the time was significantly reduced [5].

Two years later, Alkayyal and his associates, were conducting tests in 132 subjects (50 male and 82 female), who had different dental and skeletal characteristics. They analyzed the time of occlusion, occlusal balance and lateral occlusion using the T-Scan method. The obtained results showed that the time of occlusion was significantly shorter in subjects with balanced occlusion, normal occlusion and skeletal profile of Class I according to Angle, while the time of occlusion was significantly longer in subjects with reduced overlap. There was also a significant association between the distribution of occlusal balance and occlusion classes according to Angle, skeletal class, overjet and overbite, and space analysis. They concluded that ideal occlusion should be considered an ideal that clinicians should strive for with any dental treatment [6].

Abdelnabi MH, Swelem AA, Al-Dharrab AA., quantitatively investigated the influence of denture adhesives on occlusion and disocclusion time, using the computerized occlusal analysis system T-Scan. 49 subjects wearing total dentures were examined, in whom computerized occlusal adjustment was performed. In the same patients, they evaluated the retention and stabilization of the total prostheses using the modified Kapur index. Then, with the help of the T-Scan, an occlusal analysis of the total dentures was carried out, first without the adhesive, and then with the adhesive. The results showed that the use of the adhesive improved the retention and stabilization of the total dentures, resulting in a significant reduction in the duration of all occlusal parameters: occlusion time; time of disocclusion (left and right). They concluded that denture adhesive further reduced the duration of occlusal contacts after occlusal adjustment [7].

In their study, the authors Joanna, K., Teresa, S. and Maria, G. aimed to evaluate the functional parameters of occlusion in wearers of old total dentures before and after prosthetic treatment. The examined sample consisted of 50 white patients, 35 women and 15 men, aged 44 to 86, wearers of total prostheses. All subjects received new total prostheses, and each had a profile radiography done, for cephalometric analysis. To evaluate the functional parameters of the occlusion as a method, they used the T-Scan III system, and determined the following parameters: time of occlusion and time of disocclusion. The results showed a significant difference in the functional parameters obtained before the fabrication of the new total prostheses and three months after the treatment. The authors concluded that the reconstruction of the occlusal surface of the artificial teeth and the vertical dimension of the occlusion affect the sustainability of the occlusion parameters and the balance of forces in central occlusion [8].

Furthermore, the team of Bostancıoğlu SE, Toğay A, and Tamam E. aimed to compare the sensitivity of two different methods for digital occlusal analysis, that is, between the T-scan III system and the CEREC Omnicam system. Digital occlusal images were taken of individuals with a healthy masticatory system using both digital systems, in 20 men and 20 women, aged 18 to 25 years. From the comparison of the digital occlusal images, they concluded that although both systems are effective, the T-scan III system proved to be more effective, as it has a higher sensitivity [9].

Koos B, Godt A, Schille C, Göz G. investigated the accuracy of two methods: one is occlusal analysis with color marking foils (articulation paper) and the other is occlusal analysis using pressure sensitive foils i.e., with the T-Scan III system. The purpose of this study was to test the accuracy and reliability of this method. A group of 42 subjects (23 male and 19 female) aged between 20 and 30 years were examined. The obtained results showed that the T-Scan III method is superior to the usual articulating paper methods, and improves the routine diagnostics with marking foils. The combination of this method with the marking foils method would be ideal because the pressure sensitive foils in this system do not create any visible contact marks intraorally [10].

Gözler S, Vanlioglu B, Evren B, Gözneli R, Yildiz C, Özkan YK., used the computerized occlusal analysis system (T-Scan III) to evaluate the effect of a temporary hydrostatic splint on occlusion. The examined group consisted of 20 subjects (11 female, 9 male) with healthy intact dentition and neutroocclusion. Subjects were instructed to wear the hydrostatic splint continuously for 24 hours. The scans were performed before and after wearing the hydrostatic splint, and were repeated three times. Evaluation of the recordings confirmed the repeatability of the computerized occlusal analysis system. The results of the tests showed an increase in the maximum biting force, and it goes in favor of a change in the neurophysiological position of the masticatory muscles. A hydrostatic splint may be an option for occlusal adjustments [11].

IV. Conclusion

We can conclude that the T-Scan III Evolution system is a computerized method for occlusal analysis of the dentition, which shows the distribution of occlusal forces in a very fast, reliable and precise way. In fact, the method is accurate in identifying occlusal contact time as well as occlusal contact force. Further clinical studies are needed to expand the application of this system. Its use in examinations in the field of dental prosthetics is especially important.

References

[1]. Bozhkova TP. The T-SCAN System In Evaluating Occlusal Contacts. Folia Medica 2016;58(2);122-130, Doi: 10.1515/Folmed-2016-0015
[2]. Qadeer, Sarah & Kerstein, Robert & Kim, Ryan Jin-Young & Huh, Jung-Bo & Shin, Sang Wan. (2012). Relationship Between Articulation Paper Mark Size And Percentage Of Force Measured With Computerized Occlusal Analysis. The Journal Of Advanced Prosthodontics. 4. 7-12. 10.4047/Jap.2012.4.1.7
[3]. Ibraheem, E.M., Elgabry, H.S. Effect Of Mandibular Complete Dentures Relining On Occlusal Force Distribution Using T-Scan System. Bull Natl Res Cent 45, 93 (2021).
[4]. Kürklüarpacay, D. , Bayindir, F. And Dinçkalyanikoğlu, N. (2019) Evaluation Of Premature Contacts Using The T-Scan III. Open Journal Of Stomatology, 9, 136-145. Doi: 10.4236/Ojst.2019.95014
[5]. El Homossany, M., Abdallah, H. Comparing Implant Supported Mandibular Overdenture With Conventional Complete Denture Regarding Occlusion And Disocclusion Time Using T Scan. Egyptian Dental Journal, 2018; 64(Issue 2 - April (Fixed Prosthodontics, Dental Materials, Conservative Dentistry & Endodontics)): 1421-1430. Doi: 10.21608/Edj.2018.77402

[6].   Alkayyal MA, Turkistani KA, Al-Dharrab AA, Abbassy MA, Melis M, Zawawi KH. Occlusion Time, Occlusal Balance And Lateral Occlusal Scheme In Subjects With Various Dental And Skeletal Characteristics: A Prospective Clinical Study. J Oral Rehabil. 2020 Dec;47(12):1503-1510. Doi: 10.1111/Joor.13095. Epub 2020 Oct 5. PMID: 32966657

[7].   Abdelnabi MH, Swelem AA, Al-Dharrab AA. Influence Of Denture Adhesives On Occlusion And Disocclusion Times. J Prosthet Dent. 2016 Mar;115(3):306-12. Doi: 10.1016/J.Prosdent.2015.07.014. Epub 2015 Nov 6. PMID: 26553256.

[8].   Joanna, K., Teresa, S. And Maria, G. (2017) Evaluation Of Functional Parameters In The Occlusion Of Complete Denture Wearers Before And After Prosthetic Treatment. Journal Of Prosthodontic Research, 61, 480-490.

[9].   Bostancıoğlu SE, Toğay A, Tamam E. Comparison Of Two Different Digital Occlusal Analysis Methods. Clin Oral Investig. 2022 Feb;26(2):2095-2109. Doi: 10.1007/S00784-021-04191-1. Epub 2021 Oct 1. PMID: 34596770.

[10].   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. English, German. Doi: 10.1007/S00056-010-1023-7. Epub 2010 Nov 17. PMID: 21082303.

[11].   Gözler S, Vanlioglu B, Evren B, Gözneli R, Yildiz C, Özkan YK. The Effect Of Temporary Hydrostatic Splint On Occlusion With Computerized Occlusal Analysis System. Indian J Dent Res. 2012 Sep-Oct;23(5):617-22. Doi: 10.4103/0970-9290.107353. PMID: 23422607.