VOLUME - 12, ISSUE - 04, APRIL - 2023 • PRINT ISSN No. 2277 - 8160 • DOI : 10.36106/gjra

Original Research Paper

Dental Science

ACCURACY OF DIGITAL IMPRESSIONS - A REVIEW

Dr. Chandan Kumar	Post Graduate, Teerthanker Mahaveer Dental College & Research Centre, Delhi Road, Bagadpur, Moradabad, Uttar Pradesh, 244001
Dr. Shalabh Kumar	Professor, Teerthanker Mahaveer Dental College & Research Centre, Delhi Road, Bagadpur, Moradabad, Uttar Pradesh, 244001
Dr. Sujeet Patil	Post Graduate, Teerthanker Mahaveer Dental College & Research Centre, Delhi Road, Bagadpur, Moradabad, Uttar Pradesh, 244001
Dr. Ayushi Piplani	Post Graduate, Teerthanker Mahaveer Dental College & Research Centre, Delhi Road, Bagadpur, Moradabad, Uttar Pradesh, 244001
Dr. Sakshi Goyal	Post Graduate, Teerthanker Mahaveer Dental College & Research Centre, Delhi Road, Bagadpur, Moradabad, Uttar Pradesh, 244001
Dr. Anjali Dutta	Post Graduate, Teerthanker Mahaveer Dental College & Research Centre, Delhi Road, Bagadpur, Moradabad, Uttar Pradesh, 244001

ABSTRACT To simplify the oral rehabilitation procedure, digital techniques like intra oral scanners and extra oral scanners have been introduced in dentistry for impression making. Dental impressions, whether traditional or digital, are primarily used to get an impression of one or more prepared teeth, as well as neighbouring and antagonist teeth and inter occlusal relationship.

KEYWORDS :

INTRODUCTION-

Since the eighteenth century conventional impression techniques have been utilised to record the three dimensional geometry of dental tissues. But due to various reasons like wrong tray selections, a low water to powder ratio, and the expansion of tooth stone all contribute to a flawed impressions.[1] There are several issues that are found especially after prevelance of COVID - 19 in the world such as biosaety standards for disinfection, getting a correct and dependable reproduction of the oral structures, pain for patients with a strong gag reflex, storage space for the plaster models and plaster chipping or breaking that could result in a significant loss of patient data.[2]

Not only Computer Aided Design and Computer Aided Manufacturing (CAD CAM) has been popularized by the progress of digital dentistry but it has also created provisions in order to achieve more effective and reliable therapeutic results.[3]

The precision of the standard prosthetic alternatives have been accentuated by obtaining three dimensional images and additionally, it enables the virtual specifications of various treatment plans as well as the digital design and fabrication of various restorative kinds.

To simplify this oral rehabilitation procedure, digital techniques like inra oral and extra oral scanners have been introduced in dentistry for impression taking.

Dental impressions, whether traditional or digital, are primarily used to get an impression of one or more prepared teeth, as well as the neighbouring and antagonist teeth and the inter occlusion relationship. If we remove the criteria of operational and clinical differences and cost of different scanners, other than that of the improtant aspects to be concerned is the precision of the data obtained through scanning is an important factor to be taken into account.[4]

Dental professionals use intraoral scanners to take direct optical imprints. They are three dimensional scanners that project a light through its tip to scan the whole arech intraorally which includes prepared tooth for crown restoration or post and core restoration and implant scan bodies.[5]

The dimensions of dental arches are captured by these devices, the position of the dental implants can also be captured by these devices by way of the beaming of a light. A light source is projected through the high resolution cameras onto the bodies of the implant scans, tooth surfaces or dental arches.

The informations are required using high reolution cameras, processed by sophisticated software to create a polygonal mesh depicting the scanned object from a "cloud of points"; to obtain the final 3D model the scan is further processed.

An intraoral scanner collects information about projecting light. On the hardware display the reproducible tissues are then shown as naturally appearing. They are utilised to gather 3D information on the teeth that have been prepared, the teeth that are nearby, and the occlusion with the opposing dentition. The STL files that is used in digital dentistry reduces the storage area, to facilitate and speed up contact with colleagues and technicians and it also eliminates the discomfort that is associated with traditional impressions.[6]

With the passage of time, the importance of intraoral scanner has expanded, and new devices are readuly launched. It has been claimed that the use of these novel imprints in place of alginate, digital impression techniques mainly like intra oral scanners and extra oral scanners represents a paradigm shift in prosthodontics. But, evidence has to be provided to show demonstrated numerous existing intra oral scanners are comparable in terms of accuracy, dependability, time needed, and patient perception better than conventional technique of impression making to support such a statement.

There is a greater risk of failure in endodontically treated teeth compared to normal natural teeth. It is due to the fact that endodontically treated teeth have less tooth structure as compared to natural tooth. In this case, because of insufficient tooth structure post and core as a foundation is used as a

foundation for final restoration. Post and core is defined as a restorative dental materials placed in the root of a structurally damaged tooth to provide adequate retention for the core and coronal restoration. When insufficient crown tissue is left on a vital tooth to accommodate placement of a core (to support a crown), elective root treatment may be undertaken to allow for placement of an intraradicular post.[7]

The finish line accuracy when an intra oral scanner is used is the most critical component in fixed prosthodontics.

This study aims to evaluate the reporting quality of the titles and abstracts of the collected literature as well as to report on the accuracy and precision of intraoral scanning in dentistry using contemporary secondary sources.

DISCUSSION -

The current review's goal is to establish the correctness of various digital impression techniques. The repeatibility of correctness is influenced by various factors. Intra oral scanners which include data processing and scanning technology algorithm, the decision to apply powder and picture taking active triangulation, a classic scanning technique. Frequently used technique provides the highest trueness. The parallel confocal technique, in contrast need to be focused at a specific distance, such making sure that the photos are accurate regardless if the oral scanner's tip make contact with the teeth when it scans the cavity.

Sang. J . Lee and Soo. Woo. Kim conducted a study to compare the three intraoral surfaces topography and precise measurements (CEREC Omnican, iTero HD2.9 and Trios 3) and two extra oral digital scanners (3Shape D700 and Straumann Cares 3 series). They claimed in their study that the iTero scanner, which had an average 65,335 dots per area, included the most triangulation points (DPA). Next with an average of 20,103 DPA was the Trios scanner. The DPA readings from the extraoral scanners Straumann Cares and 3Shape were 15,288 and 14,794 respectively. The intraoral scanner from CEREC, the Omnican captured the fewest triangultion points. The Straumann Cares scanner displayed the best level of measuring precision with the value of 4,910 and CEREC Omnican showed the value of 4,850. Extra oral scanner 3Shape generated the result of 2,107 and intraoral scanner iTero generated the result of 749.[8](Table 1)

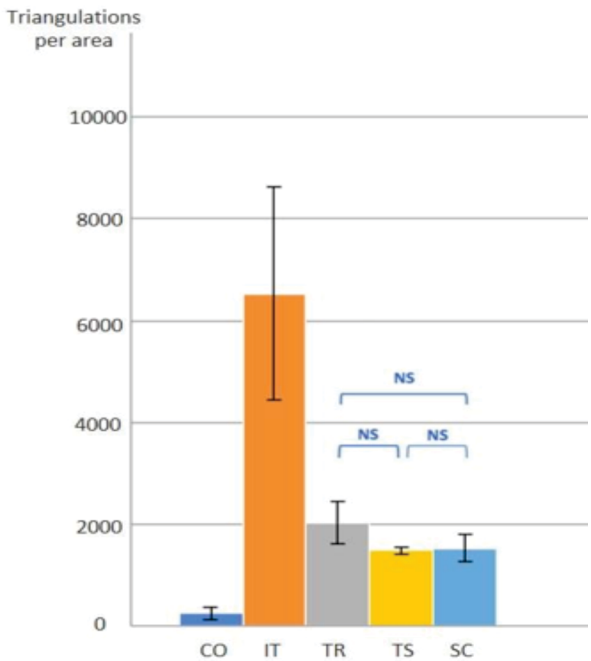

Table 1

For CAD/CAM-P+C, traditional and digital impression methods were compared pertaining to impression depth in an invitro insetigation by Pinto et al. In the current investigation, the investigated region and the apical measurement area were compared. In comparison to the traditional impression technique, Pinto et al reprted for all digital impressions generated using IOS Trio, the average variance was 19.58%.[9] Zahra Jafarian and Mohammad Moharrami in their study to check the utilization and retention of tradtional and digitally manufactured post and cores in canals with round and oval shapes reported that in both the round and oval canals, the when the wash weight, apical gap, and post volume were considered, cast posts and cores showed considerably superior adaptability than the milled group. Round and oval canals had no impact on the post and core adaptation, with the exception of the milling groups apical gap. The retention of the milled posts was the same for both round and oval posts.[10]

Gurusharan Kaur Sason and Guarang Mistry did an in vitro study on the comparative evaluation of digital impressions taken intra and extra oral. For this study, ten male and female dentulous volunteers between the ages of 18 and 45 with a mandibular first molar that had undergone endodontic treatment and was asymptomatic but still had its neighbouring teeth was chosen. To gather reference datasets. A digital vernier calliper was used to take measurements of the prepared test tooth. The extraoral scanners were then collected utilising the imprints used to make the casts after the tooth had been scanned intraorally. The datasets were split into four groups and statistical analysis was performed. The refernce datasets were obtained intraorally using a digital vernier calliper after that a round diamond point was used to create dimples on the bucco-occlusal, mesio-occlusal, disto-occlusal and lingua-occlusal line angles after the test tooth had been prepared. Following three scans with the IO scanner (CS 3500, Carestream Dental) of the test tooth, impressions were also made using additional silicone impression material (3MTM ESPE). The type IV dental stone (Kalrock-Kalabhai Karson India Pvt. Ltd. India) was then filled with dental castings, which were then three times scanned using the EO scanner (LAVATM scan ST Design system [3MTM ESPE]). Readings were taken utilising the extraoral and intraoral scanner datasets supplied to Dental Wings Software.

For intraoral scanners, the precision values varied from 20.7 to 33.35um, and for extraoral scanners, they ranged from 19.5 to 37um. The intraoral scanner's mean deviations were 16.4 um buccolingually and 19.6um mesiodistally while for the extraoral scanners, they ranged from 24um and 22.5 um. The intraoral scanner's mean trueness values (413um) were the closest to the actual measurements (459um) when compared to extraoral scanner's (396um). Hence, they concluded that intra oral scanners showed greater degree of precision and trueness when compared to extra oral scanners.[11]

Jaafar Abduo and Joseph E. A. Palamera researched an in vitro study about the accuracy of digital impressions and conventional impressions of two implants to study the effect of implant angulation. Two tissue level implants were used to create one model featured parallel implants, and the other had one 15 degree tilted implant in in vitro 3-unit prosthetic master models. With impression copings that are both splinted and not splinted, the tradtional open tray imprints were made. Digital impressions were created using scan bodies and Trios 4 (TS), Medit i500(MT) and True Definition (TD) software programmes. With each method, a total of 10 imprints were made. Two virtual implant images were created using the virtual test versions of the analogue and digital impressions. Each group's accuracy, precision, inter-implant distance deviation and angle were evaluated.

Digital impression had a tendancy to deliver results for trueness, accuracy, and angle deviation that were more

accurate overall. With the exception of angle deviation, where the splinted impression copings for the diverging implants model significantly outperformed the non-splinted impression copings, the two conventional impressions demonstrated comparable accuracy. Among all the IOS systems, the True Definition was typically the least accurate, particularly for the inter implant distance variation.[12]

Hironari Hayama and Kenji Feuki in their study to compare the accuracy and precision of digital impressions taken with various intraoral scanners and a partly edentulous mandible utilising various head sizes concluded that the accuracy of digital impressions is largely comparable to that of traditional impressions; however, removable partial denture fabrication may benefit from the use of a larger scanning head. [13]

Popkong Amornvit and Dinesh Rokaya in their study to compare the accuracy of ten intra oral scanners which were developed between the years 2015 to 2020. This was used to print a maxillary dental model with reference points. Each intra oral scanner was used to scan the model five times (IOS). The ten IOS used were; Trios 3 (normal and high resolution mode); Trios 4 ; iTero Element, iTero 2 and iTero 5D Element; Dental Wings; Panda 2; Medit i500; Planmeca Emerald; and Aoralscan. In their study they arrived at the conclusion that the accuracy was inconsistent but generally similar across all examined scanners. All of the scanner's accuracy during diagonal scanning was lower. Therefore, the dentist must exercise greater caution and use a proper scan pattern when scanning the entire arch. When compared to other scanners, Trios series displayed the best scan results.[14]

Ala Omar Ali in his study on accuracy of digital impressions achieved from five different digital impression systems prepared a typhodont for a three unit bridge. The reference model was then captured digitally by a lab scanner. The various systems were used to scan the epoxy resin reference model (3M Lava C.O.C, 3Shape D900, Cadent iTero, CEREC Bluecam and E4D Dentist), which each produced five digital imprints (n=5). The variations between the digital reference model and digital impressions were measured spatially using computer software. The following were the measurements for mean difference (standard deviation): 23um CadentiTero, 36um 3M LAVA C.O.C, 18um 3Shape D900, 68um CEREC Bluecam and 84um E4D.[15]

Jason. L. Porter in his study to compare the precision of digital model articulation using intraoral and extraoral scanners. In five experimented groups, 25 digital articulated models were created using four digital scanners. The final inter arch measurements were contrasted with the benchmark. Evaluation was performed within 0.5mm above or below the gold standard is considered to be an acceptable range. In his study, all appropriate inter arch measurements were produced by iTero and iTero Element. Four of the six interarch measurements reported by the OrthoInsight 3D with Regisil bite registration and 3MTM True Definition were both satisfactory. Three out of six valid inter arch measurements were obtained using the Ortho Insight 3D with Coprwax TM bite registration. They concluded from their study that the models made by the iTero and iTero Element were expressed most precisely.

The next most accurate products were Ortho Insight 3D with Regisil and 3MTM True Defintion. The least accurate technique evaluated was the Ortho Insight 3D scanner with Coprwax TM.[16]

Naiyu Cui and Jiayin Wang in their bias study for the evaluation of the two extra oral scanners, they used two extra oral scanners (E4 3Shape, Denmark and SHINNING DS100) and an intra oral scanner (Trios 3). They ran 30 scans of each of the three samples at a temperature of 25 degree celsius using reverse engineering software for measurements and iterative nearest point matching. The experimental results demonstrated that the extraoral scanners were accurate and true, but the intraoral scanner had a slight mean variation. The trueness and precision of the three scanners are inadequate on the curved surface and groove parts. E4 performed better in terms of accuracy and replicability than SHINNING and TRIOS. Excellent matching outcomes were also obtained in the iterative nearest point matching experiment and we anticipate that digital technology will be used in dentistry more frequently in the future.[17]

Sunil Dogra and Vishal Sharma in their study of comparison of digital impressions taken intra and extra orally. For the study, 10 patients between the ages of 18 and 50 who were missing teeth and had their mandibular first molars endodontically treated were chosen. According to biome chanical principles, the tooth preparation was carried out. It was noticed that the intra oral scanner's mean deviation of measurements from buccal, lingual and mesio impels were more accurate than the extra oral scanner's.[18]

Asher Chiu and Yen Wei Chen in their study to find out the accuracy of CAD/CAM digital impressions with different intra oral scanner parameters.[19]

CONCLUSION -

Systems for taking digital intra oral impressions are still evolving quickly. Because the data are heterogenous. It was challenging to directly compare specific research to reach an overall conclusion about the veracity using IOSs as a number of study variables in the lab or in the clinical setting, looking for an entire arch, a portion of an edentulous arch.

Accuracy is measured in terms of resolution for a single tooth are employed to assess the precision of scanners. The precisionof IOS is impacted by a number of elements, such as the scanner technology, scanning of powdery materials, software and methods for scanning. Therefore, short span scanning and diagnostic purposes can be successfully carried out using intraoral scaiing technologies as opposed to traditional imprints. The IOS, however, is more sensitive to variation while scanning an entire arch. The Investigations showed that the various IOS systems had varying results. Even though IOS system's accuracy seems to be promising and on par with traditional techniques, they are nevertheless prone to errors, scanning software and scanning tactics.

REFERENCES -

1. Abigail Coutinho C, Hegde D, Shetty S, Iyer R, Priya A. INTRAORAL SCANNERS: A NARRATIVE REVIEW. Joural of Research in Dentistry. 2020 May 7;8(1):1.
2. Hong-Seok P, Chintal S. Development of High Speed and High Accuracy 3D Dental Intra Oral Scanner. Procedia Engineering. 2015;100:1174-1181.
3. Aswani K, Wankhade S, Khalikar A, Deagade S. Accuracy of an intraoral digital impression: A review. The Journal of Indian Prosthodontic Society. 2020;20(1)27.
4. Cicciu M, Fiorillo L, D Amico C, Gambino D, Amantia EM, Laino L, et al, 3D Digital Impression Systems Compared with Tradition Techniques in Dentistry: A Recent Data Systemic Review. 2020 Apr23;13(8):1982.
5. Mangano F, Gandolfi A, Luongo G, Logozzo S. Intraoral scanners in dentistry: a review of the current literature. BMC Oral Health. 2017 dec,17(1).
6. Pellitteri F, Albertini P, Vogrig A, Spedicato GA, Siciliani G, Lombardo L. Comparative analysis of intraoral scanners accuracy using 3D software:An in vivo study. Progress in Orthodontics. 2022 Jul 4;23(1).
7. Mannocci F. Research that matters: restoration of endodontically treated teeth. International Endodontic Journal. 2013 Mar 22;46(5):389-390
8. Lee SJ, Kim SW, Lee JJ, Cheong CW. Comparison of Intraoral and Extraoral Digital Scanners: Evaluation of Surface Topography and Precision. Dentistry Journal. 2020 May 20;8(2):52.
9. Pinto A. IN VITRO EVALUATION OF THE POST SPACE DEPTH READING WITH AN INTRAORAL SCANNER (IOS) COMPARED TO A TRADITIONAL SILICON IMPRESSION. Oral & Implantology. 2017;10(4):360.
10. Jafarian Z, Moharrami M, Sahebi M, Alikhasi M. Adaptation and Retention of Conventional and Digitally Fabricated Posts and Cores in Round and Oval Shaped Canals. The International Journal of Prosthodontics. 2020 Jan;33(1):91-98.
11. Sason G, Mistry G, Tabassum R, Shetty O. A comparative evaluation of intraoral and extraoral digital impressions: An in vivo study. The Journal of Indian Prosthodontic Society. 2018;18(2):108.

12. Abduo J, Palamara JEA. Accuracy of digital impressions versus conventional impressions for 2 implants: an in vivo study evaluating the effect of implant angulation. International Journal of Implant Dentistry. 2021 Jul 30;7(1).
13. Hayama H, Feuki K, Wadachi J, Wakabayashi N. Trueness and Precision of digital impressions obtained using an intraoral scanner with different head size in the partially edentulous mandible. Journal of Prosthodontic Research . 2018 Jul;62(3):347-352.
14. Amornvit P, Rokaya D, Peampring C, Sanohkan S. Confocal 3D Optical Intraoral Scanners and Comparison of Image Capturing Accuracy. Computers, Materials & Continua. 2020;66(1):303-314.
15. Accuracy of Digital Impressions Achieved From Five Different Digital Impression Systems. Dentistry.2015;05(05).
16. Porter JL, Carrico CK, Lindauer SJ, Tufecki E. Comparison of intraoral and extraoral scanners on the accuracy of digital model articulation. Journal of Orthodontics. 2018 Jul 19;45(4):275-282.
17. Cui N, Wang J, Hou X, Sun S, Huang Q, Lim HK. Bias Evaluation of the Accuracy of Two Extraoral Scanners and an Intraoral Scanner Based on ADA Standards. Ardelean LC, editor. Scanning. 2021 Jun 10;2021:1-13.
18. Journal of Advanced Medical and Dental Sciences Research.
19. Chiu A, Chen YW, Hayashi J, Sadr A. Accuracy of CAD/CAM Digital Impressions with Different Intraoral Scanner Parameters. Sensors (Basel, Switzerland).2020 Feb 20;20(4).