ISSN: 2581-5989
PubMed - National Library of Medicine - ID: 101738774

International Journal of Dental Science and Innovative Research (IJDSIR)

IJDSIR : Dental Publication Service

Available Online at: www.ijdsir.com

Volume – 4, Issue – 6, November - 2021, Page No. : 98 - 103

Digital workflow in implant dentistry: A review

[1]Dr. Mahavish Khan, Post Graduate, Periodontology and Implantology, M. A. Rangoonwala College of Dental Sciences and Research Institute, Pune

[2]Dr. Sangeeta Muglikar, Professor and HOD, Periodontology and Implantology, M.A. Rangoonwala College of Dental Sciences and Research Institute Pune

[3]Dr. Salika Sheikh, Professor, Periodontology and Implantology, M.A. Rangoonwala College of Dental Sciences and Research Institute Pune

[4]Dr. Farha Shaikh, Post Graduate, Periodontology and Implantology, M.A. Rangoonwala College of Dental Sciences and Research Institute Pune

[5]Dr. Bhagyashree Jabade, Lecturer, Periodontology and Implantology, M.A. Rangoonwala College of Dental Sciences and Research Institute Pune

Corresponding Author: Dr. Mahavish Khan, Post Graduate, Periodontology and Implantology, M. A. Rangoonwala College of Dental Sciences and Research Institute, Pune

Citation of this Article: Dr. Mahavish Khan, Dr. Sangeeta Muglikar, Dr. Salika Sheikh, Dr.Farha Shaikh, Dr. Bhagyashree Jabade, "Digital workflow in implant dentistry: A review", IJDSIR- November - 2021, Vol. – 4, Issue - 6, P. No. 98 – 103.

Type of Publication: Review Article

Conflicts of Interest: Nil

Abstract

Science and technology have evolved so far to digital era. Introduction of newer equipment hardware, software and machineries and their implementation in clinical implant dentistry making diagnosis planning and treatment easier and more precise overcoming the limitations of the conventional workflow. This article focuses on illustrating the application of digital technology and reviewing the pre-operative planning, surgical phase and prosthetic reconstruction in digital workflow in implant dentistry.

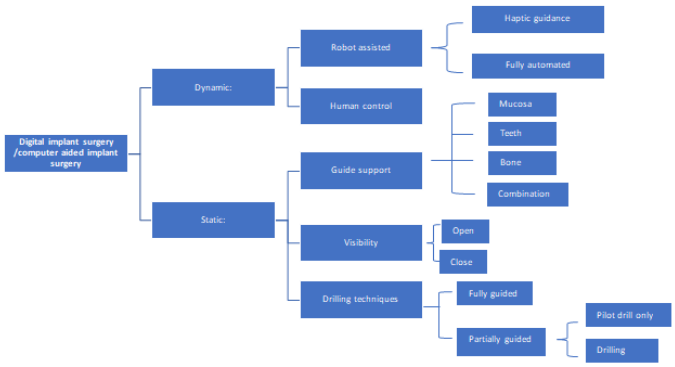
Keywords: intraoral scanners, surgical guide, surgical navigation, digital articulator, CAD, CAM

Introduction

The continuous progress in the digital technologies and processing ensures innovative opportunities in the field of fixed prosthodontics. Implants are one of the most exciting facets of dentistry that has evolved by computer technology. This era has progressed to digital dentistry beyond the innovators and early adopter period. There are several aspects of technology and innovation that have been utilized to make this aspect more digitalized and aids in diagnosis, treatment planning and delivery of

dental implant therapy.[1] The digital implant-prosthetic protocol provided a smooth, time effective and least complicated treatment alternative over the conventional workflow. As per the various systematic reviews, the concept of digital workflow has improved and modernized the treatment in efficiency and fulfilment of patient's perceptions which is designated as the real-time micro placement of implant. The purpose of this article is to review the implementation of digital technology in the treatment planning and operative phases, surgical placement and prosthetic steps in computer guided implant treatment.[2]

Classification of digital implant surgery / computer aided implant surgery:



Following are he steps in digital implant prosthodontics

Intraoral scan technologies in diagnosis

Intraoral scanners (IOS) are devices which are used to capture direct virtual impressions in dentistry. Pre-surgical intra-oral scanning is the preliminary step wherein technology can be applied in implant dentistry.[2,3]

As the other three-dimensional scanners, they also project a light source over an object which is to be scanned. The images of the dento-gingival tissues as well as the implant scan bodies captured by imaging sensors are processed by the scanning software, which generates point clouds.

These point clouds are then triangulated by the same software, creating a 3D surface model. The 3D surface models of the dento-gingival tissues are the result of the virtual impression and are the optical alternative to conventional plaster models. The intraoral scanners should present high trueness and precision.[3]

Digital impressions

Various impression methods have been introduced for accuracy which includes transfer or pick-up technique, impression materials and coping modification. Digital impressions transfer the intra-oral situation to optical model which represent the first step of the digital workflow.[4]Digital impressions can accelerate the data-capturing process and omits most of the drawbacks frequently associated with conventional impressions, thereby decreasing patient's discomfort while improving the predictability of prosthesis design and manufacturing procedures.

Diagnostic waxed-up

After obtaining the diagnostic IO scans, the next crucial component to computer guided implant planning and execution is the diagnostic wax-up, that allows to create a three-dimensional communication tool that guides the prosthetically driven implant planning and placement. These wax-ups can be virtually designed by using dental laboratory software.[5] This will allow the clinician and patient to visualize the case prior to treatment and do the required modifications in tooth shape, size, or morphology by using the tools within the software. Once the final design is accomplished, the wax-up can be produced via digital manufacturing.

Virtual Planning step in workflow

The introduction of cone-beam computerized tomography scanning, in combination with three-dimensional scanning tools, has led to a major revolution in virtual implant treatment planning. After the intraoral

scanned files or Digital Imaging and Communication in Medicine (DICOM). [5,6]

DICOM files are imported into a virtual implant planning software package where they can be segmented to reduce the 3D area and to enhance the image by removing scatter and any other artifacts, or to separate the different anatomical elements within the file.

3D Printing of surgical guide for implant surgery

Guided implant surgery systems use a combination of hardware and software to facilitate the planning of implant positions. The resulting positions are then converted into surgical guides or loaded into positioning software using a variety of methods.[7] These novel approaches improve positioning and accuracy in terms of the relationship between virtually planned and real-life insertion of the implant

The systems are classified as followed:

Surgical technique for fully guided implant placement

Generally, two types of guided implant surgery protocols for static and dynamic are described in the literature. The static approach refers to the use of a static surgical template. This reproduces the virtual implant position directly from computerized tomographic data to a surgical guide, which does not allow intra-operative modification of the implant position.[7,8] Another option, called the stereolithographic method, uses specifically designed software to design virtually the surgical stent and afterwards fabricate it using polymerization of an ultraviolet sensitive liquid resin.

Whereas, the dynamic approach, also called navigation, refers to the use of a surgical navigation system that reproduces the virtual implant position directly from computerized tomographic data and allows intra-operative changes of the implant position.

Surgical navigation

These systems are based on motion tracking technology that allows real-time tracking of the dental drill and the patient throughout the entire surgery. By superimposing images obtained from cone-beam computerized tomography and intra-oral scanning, a more realistic digital view of the dental hard and soft tissues of a patient is created. A digital set-up can also be added to this data set, to assist dental professionals to execute the planning in relation to the future prosthetic restoration.[9]

Flap or flapless surgery

As in general medicine, implant dentistry has evolved toward increased use of minimally invasive procedures. In this respect, guided implant surgery is a valuable adjunct. Implant installation can be performed either freehand after drilling through the soft tissue or by using a surgical guide. The advantage of the minimal surgical procedure lies in preservation of the blood circulation in the soft tissues, which may affect the soft-tissue architecture. In a systematic review by **Cosyn et al.**

concluded that a flapless approach reduced bone loss but also enhanced papilla regrowth and hence the esthetic outcome of single implants. The flapless approach is beneficial to patients as considerably less postoperative morbidity and discomfort has been reported compared with open flap surgery.[10]

Prosthetic step

Intraoral scanning digital impression: Intra-oral scanning is also being applied in the restorative phase of implant dentistry.

Following successful osseointegration, IOS scans are made to transfer the implant position from the oral cavity to the digital lab. This STL file is now imported into the CAD station to begin the prosthetic fabrication via CAD/CAM processes.[11] The precise implant position and orientation is recognized by the orientation of the scan body captured in the STL file, allowing the digital lab to proceed with the digital articulation and digital selection of prosthetic components for the fabrication of the final implant restoration.

Digital Articulator

The types of articulators available for use within the digital environment has evolved and expanded as CAD software packages have been developed.

Three types of digital articulation exist within the digital workflow:

Mechanical articulation with a digital interface:

Wherein class III or class IV articulators are used, the plaster cast are mounted on removable plates on the actual mechanical articulator, then the scanning of the cast are carried out by a desktop scanner to locate them in the CAD software.[10,11]

Simple digital articulation

It involves two methods

- IOS scanning: - Using an intraoral scanner the occlusal surfaces are scanned and imported into the CAD software. It is used for sectional scans of arch rather than full arch scan.
- Model scanning with an occlusion medium: - This technique provides an occlusal analysis and its use is restricted to restorations where final anatomy is copied from pre-existing occlusal morphology.[12]

Virtual digital articulation

It provides the evaluation of the static and dynamic jaw movements using virtual-reality technology. The jaw-movement recording system are available in three categories ultrasound- based, voltage division method and optoelectronic system

Prostheses fabrication techniques and material:

Developments in CAD/CAM technology and the increasingly industrialized manufacture of dental prostheses have provided a growing range of new materials.[13]

Materials can be selected at one of three levels:

• Abutment level

• Framework level

• Integrated abutment/framework complex

CAD/CAM

Computer aided design

CAD software allows for the final prosthesis to be designed virtually. The entire process is covered, from the diagnostic set-up to the final design for simple or complex, fixed or removable prostheses. The software uses specific design parameters to control the manufacturing tolerance within the system. Angulations of implant positions, abutment shapes, and contours can be individually customized, parallelism can be carefully controlled and easy to configure, connector thicknesses can be calculated and confirmed as adequate for preventing material failure under functional load.[14] The software allows for a variety of implant analog replicas to be virtually positioned within the model.

Computer aided manufacturing

After the obtaining of the virtual model, the structure or restoration can be virtually designed on the software. The last stage in the production of the final prosthesis is the milling process. The data is sent to a milling unit, which performs the process of machining the designed digital project with high precision and a significant reduction of the clinical and laboratorial time.[15,16]

Three different production concepts are available depending on the location of the components of the CAD/CAM system: chairside or in office production; laboratory production or centralized fabrication in a production centre.

Merits of guided implant placement:

1. Bone augmentation procedures may be avoided by improving implant positioning in available bone (Fortin et al. 2009).
2. An ideal implant placement can be virtually implemented in a prosthetically driven manner.
3. By using the link of transferring the exact positioning of implants from the presurgical planning to the dental laboratory the CAD/CAM technique has made manufacturing of fixed prosthesis feasible which can directly connect to the newly inserted implant fixtures.
4. Provides more precise and accurate placement of dental implants where in a special computer program is used to create a surgical template that is used to determine the optimal location for placement.
5. Guided implant surgery can reduce surgery time, reduce surgical risk, and can immediately restore dental function thus increasing patient satisfaction.

Limitations of guided implant dentistry:

1. Despite the increasing popularity of implant placement using CAD/CAM surgical guides there is no perfect accuracy in the clinical situation. Thus, the operators should be aware of the linear and angular deviations up to 5° and 2.3 mm which can occur due to anatomic variations.
2. It requires CT and additional software and the additional costs of the surgical drill kit and guide preparation for the guided surgery.

Conclusion

Dental technology has the capability to invade every area of clinical implant dentistry due to ongoing ingress of new hardware and software into the market. This technology applied to fabricate prosthesis for implant by producing the interim and final restorations of the implants, determining its use in every stage of implant dentistry. It also benefits the dentist to discuss and exhibit the final outcome of the treatment with the patient through the digital data obtained. This generates a positive impact on patient providing greater patient compliance and acceptance.

References

1. Ludlow M, Renne W. Digital workflow in implant dentistry. Curr Oral Health Rep. April 2017:1-5.
2. Rossini G, Parrini S, Castroflorio T, Deregibus A, Debernardi C. Diagnostic accuracy and measurement sensitivity of digital models for orthodontic purposes: a systematic review. Am J Orthod Dentofac Orthop. 2016; 149:161-70.
3. Hack G, Patzelt S. Evaluation of the accuracy of six intra-oral scanning devices: an in-vitro investigation. JADA. 2015; 10:1-5.
4. Renne W, Ludlow M, Fryml J, Schurch Z, Mennito A, Kessler R, Lauer A. Evaluation of the accuracy of seven digital scanners: an in-vitro analysis based on 3- dimensional comparisions. J Pros Dent2016 JPD-D-16-00503R5.
5. Gherlone E, Cappare P, Vinci R, Ferrini F, Gastaldi G, Crespi R. Conventional versus digital impresions

for “all-on-four” restorations. Int J Oral Maxillofac Implants. 2016; 31:324-30.

6. Joda T, Lenherr P, Dedem P, Kovaltschuk I, Bragger U, Zitzmann N. Time efficiency, difficulty, and operator’s preference comparing digital and conventional implant impressions: a randomized controlled trial. Clin Oral Impl Res.2016:1-6.
7. Joda T, Bragger U. Patient-centered outcomes comparing digital and conventional implant impression procedures: a randomized crossover trial. Clin Oral Impl Res. 2015:1-5.
8. P. Hong-Seok and S. Chintal, “Development of high speed and high accuracy 3D dental intra oral scanner,” Procedia Engineering, vol. 100, pp. 1174–1181, 2015.
9. Alghazzawi, “Advancements in CAD/CAM technology: options for practical implementation,” Journal of Prosthodontic Research, vol. 60, no. 2, pp. 72–84, 2016.
10. S. Logozzo, E. M. Zanetti, G. Franceschini, A. Kilpelä, and A. Mäkynen, “Recent advances in dental optics - part I: 3D intraoral scanners for restorative dentistry,” Optics and Lasers in Engineering, vol. 54, pp. 203–221, 2014.
11. B. Giménez, M. Özcan, F. Martínez-Rus, and G. Pradíes, “Accuracy of a digital impression system based on active wavefront sampling technology for implants considering operator experience, implant angulation, and depth,” Clinical Implant Dentistry and Related Research, Supplement 1, pp. e54–e64, 2015.
12. O. Aubreton, A. Bajard, B. Verney, and F. Truchetet, “Infrared system for 3D scanning of metallic surfaces,” Machine Vision and Applications, vol. 24, no. 7, pp. 1513–1524, 2013.
13. J Abduo, K Lyons. Rationale for the use of CAD-CAM technology in implant prosthodontics. Int J Dent. **2013**; 2013:768121.
14. J Abduo. Fit of CAD/CAM implant frameworks: a comprehensive review. J Oral Implantol. 2014 Dec; 40(6): 758–766.
15. I Abrahamsson, T Berglundh, PO Glantz, J Lindhe. The mucosal attachment at different abutments. An experimental study in dogs. J Clin Periodontol. 1998 Sep; 25(9): 721–727.
16. I Abrahamsson, G Cardaropoli. Peri-implant hard and soft tissue integration to dental implants made of titanium and gold. Clin Oral Implants Res. 2007 Jun; 18(3): 269–274. Epub 2007 Feb 13.