



## DIGITALIZED PROSTHODONTICS - A REVIEW

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**ABSTRACT** With the passing years and the perpetual development in research, emerged an array of options in dentistry. The contemporary dental practice with endless options can preserve the oral health by reducing the treatment time, minimizing errors and improving quality. Continuous technological progress in dental-fabrication processes ensures new opportunities in clinical workflow. There is an endless scope of digitisation in Prosthodontics - let it be in the diagnostic and treatment procedures like the use of digital radiographs, virtual articulators, T-scan, joint vibration analysis, digital photographs and casts, digital surveying, digital impressions or in the clinical and lab procedures like use of CAD-CAM technology, stereolithography and rapid prototyping, digital shade guides, digital smile designing, audiovisual aids,...the list remains endless. This article reviews various aspects of Prosthodontics where digitization has modified the conventional procedures. For discussion they have been considered under diagnostics and treatment procedures, clinical and laboratory procedures.

**KEYWORDS :** Digitalization, Digital radiography, Digital impressions, Digital smile designing, Prosthodontics.

**INTRODUCTION:**

The most recent developments in technology made all things possible in this world. The reality is that the high quality dental services can be routinely rendered through the effort of dental specialist and technicians. Nevertheless, dental laboratory work still depends on the experience and remains to be labour-intensive<sup>1</sup>. All through the treatment procedure, from treatment planning to final restoration, the communication between the dental expert and the technician require a complete exchange of data pertaining to existing, realistic and desired situations and expectations to and from the clinical condition. Functional components, occlusal parameters, phonetics and aesthetics are just some of the essential information that the dental specialist can finish with his abilities and experience<sup>2</sup>.

The contemporary dental practice has unlimited options for preserving oral health and provides next to natural aesthetics with an enhanced approach, lessened treatment time, minimal errors and better quality assurance<sup>3</sup>.

Digitalized dentistry empowers efficient, quick and precise and error free production of fixed Prosthodontics restorations. Computer aided design/computer aided manufacturing (CAD-CAM) technology was introduced in early 1980's that paved a way for digitalization<sup>4</sup>. There is interminable extent of digitalization and innovation in Prosthodontics- let it be in the clinical and lab procedures like use of CAD-CAM technology, use of virtual articulators, digital radiographs, or in the field of training education and research by the use of virtual patient program, recording of jaw motion, retention testing device, audio visual aids and this list will remain endless.

Research is likewise proceeding into the development of credit card size 'smart card', which could convey a patient's medical and dental data alongside their radiographic images. It is vital that advances in innovation are acknowledged and the advantages that they deliver are used together so that clinical practice and patient care keep on improving<sup>5</sup>.

**DIGITALIZATION IN DIAGNOSIS AND TREATMENT PLANNING:**

**DIGITAL RADIOGRAPHY:** A good treatment begins with the right diagnosis, and the dental radiographs have been an important diagnostic aid from the start. Film has been an inexpensive and reliable image receptor<sup>6</sup> however, there are certain disadvantages that includes:

- The time required to process the film interrupting the dental

treatment,

- Variability of image quality associated with chemical film processing,
- It require much space and manipulation of film-based images is impossible after processing.

**Advantages of digital radiography:**

- To distinguish the earliest changes that could affect the hard tissues,
- Offers immediate viewing of images which is highly desirable during implant procedures
- Image quality, image acquisition, Image manipulation, automated analysis, and application software

**Disadvantages of digital radiography:**

- Software related barriers need to be overcome
- Its high cost also does not encourage many of the practitioners

Three-dimensional imaging, particularly cone-beam computed tomography (CBCT), has made significant contributions to the planning and placement of implants to replace missing teeth<sup>8</sup>.

Uses of CBCT Technology: Diagnosis, Clinical application, Clinical evaluation of treatment outcomes

**Clinical Applications of the CBCT:**

CBCT provides information for 3D models made by rapid prototyping. The obtained 3D models can serve as a matrix that enables precise planning of operations such as for mini-implant positions in anatomically complex sites. CBCT is also a tool for the evaluation of surgical and orthodontic treatment. There have not been a lot of papers published but they are increasing in their number as the CBCT is becoming more readily available.

**T-SCAN:**

Diagnosing and treating occlusal errors has never been easy. To analyze the problems arising from occlusal origin constitute a great difficulty due to the complex nature of the human occlusal system. Systems like Tekscan (T scan) and Matscan permit a precise study of occlusal contacts and the forces created; examining even slightest of occlusal interferences, significant in full mouth rehabilitation and implant protected occlusion.

It register the patient occlusion on a thin patented 60 microns thickness disposable sensor to record instantaneously the patient bite in terms of

location, timing and force of every tooth in contact. This record is transferred to a computer that can simulate patient occlusion on a monitor, assuming the different situations possible during centric, eccentric and functional movements. This provides both qualitative and quantitative assessment of occlusion<sup>9</sup>.

**Advantages:** Simple operation, 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 carrying on the various treatment protocols.

**VIRTUAL ARTICULATORS:**

The transition from numerous mechanical articulator designs to recently developed virtual articulators is a breakthrough in the development of the articulator design. Mechanical articulators are different from the real life biological setting; they cannot simulate masticatory movements that are dependent upon the muscle patterns and resilience of the soft tissues and joint disc. Moreover, tooth mobility cannot be simulated by plaster models; as a result, the latter are unable to reproduce the real life dynamic conditions of occlusion<sup>10</sup>.

**Advantages of Virtual Articulator:**

- Can analyse both static and dynamic occlusions.
- Provides best quality of communication between the dentist and dental technician
- Designing of occlusal surface using CAD CAM system.
- Analyses gnathic and joint conditions.
- Can simulate the specific masticatory movement of the patient
- Offers a detailed 3-D visualization of region of interest.
- Possibility to modify or introduce new setting according to the patient

**JOINT VIBRATION ANALYSIS (JVA):**

JVA is based on simple principles of motion and friction: When smooth surfaces rub together, little friction is created and thus little vibration. However, if surfaces become rough, then friction causes vibrations when these surfaces articulate. The smooth, well-lubricated surfaces in a healthy TMJ joint have a biomechanical relationship that produces very little friction and almost no vibration. Surface changes that are caused by subtle degenerations, perforations or mechanical displacements will generally produce friction and some vibration. Different disorders produce different vibration patterns or “signatures”<sup>11</sup>.

**Advantages:**

- The ability to store and compare observations at different times.
- To record frequency sound and vibrations that would not be perceived by the human ear.
- To eliminate differences resulting from differences in hearing and perception of the viewer.
- To make objective documentation of the sound and its character.
- The ability to analyze the vibration with respect to amplitude energy content and frequency distribution.

**DIGITIZATION OF PHOTOGRAPHS AND DIAGNOSTIC CASTS**

The generated digital models after scanning the plaster casts, were proven reliable and clinically acceptable for measuring tooth and inter tooth dimensions Digital photography quickly replaced film and digital cameras are now fully integrated in smartphones<sup>12</sup>.

**Advantages of digital photographs :** Relatively low cost of storage, the archived nature of the document, the relative accuracy of photographs versus clinician's memory of previous conditions, documentation, enhances communication.

**DIGITAL SURVEYING:** Electronic surveying of a scanned cast can create a pattern for the fabrication of metal framework on the computer screen following the principles of removable partial denture design. Programs were written for this study using mathematical software that reads in triangular faceted surface models. The survey line was identified electronically by writing a mathematical program that can identify all downward facing surface triangles on the computer scan<sup>13</sup>

**DIGITAL IMPRESSION:** Impression making is an indispensable part of Prosthodontics, and digital impressions have revolutionised this task. These omit the use of materials and their related inaccuracies.

3D optical digitising technology allows 3D images to be scanned with a 3D scanner and these can be coupled with computerised milling machines for processing restorations.

**Advantages<sup>14</sup>:**

- Eliminate the uncomfortable experience of making a physical impression.
- Incredible teaching tool because you can evaluate your preparation
- The accuracy of the mounting, bite registration, and stability of the dies Immediate- and long-term benefits are realized by being able to see if proper occlusal reduction has been achieved.
- Noticeable reduction in remakes.
- Disinfection of impressions is now a non-issue with a digital system.
- Record keeping.
- Reduction of inventory, streamlining procedures, and going green

**DIGITALIZATION IN CLINICAL AND LABORATORY ASPECTS:**

**CAD CAM:** CAD/CAM was introduced in dentistry in the year of 1971. The use of CAD/CAM technology in dentistry is increasing, both in the dental laboratory (Table 1) and general practice settings, to fabricate all-ceramic inlays, onlays, crowns, and veneers<sup>4</sup>.

**Definition:** CAD/CAM Systems: Computer Aided Designing/ Computer Aided Machining systems that can produce dental prosthesis with help of robots or computers<sup>5</sup>.

**General Principles of CAD/CAM<sup>5</sup>:**

- All true CAD/CAM systems exhibit three computer-linked functional components, although the degree of sophistication may differ.
- A means of data acquisition
- Restoration design.
- Restorative production.

**Uses of CAD/CAM<sup>5</sup>:**

- Fabrication of Inlays and onlays, crowns and bridges
- Post and cores fabrication
- Fabrication of Complete dentures and Removable Partial Denture Prosthesis
- Designing the placement of the Implant
- Maxillo facial prosthesis designing

3D-SCAN

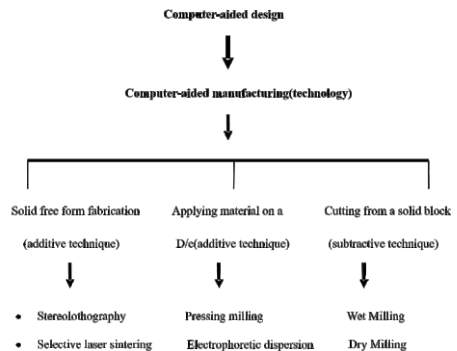


Table1 : CAD CAM TECHNIQUES

**DIGITAL SHADE GUIDE:**

Another area of digital application has been shade replication, and this has always been prone for inter and intra operator variability. Visual shade matching is now being overrun with methods like photography, colorimeters and spectrophotometers (Shade Match, Shade Vision, Shade Eye and Clear Match) which give more consistent shade and a near life effect with colour mapping of tooth selected. Digital imaging and shade matching decrease the interoperator and intra-operator variability; and also eases the communication with the lab technician<sup>15</sup>

**DIGITAL SMILE DESIGNING:**

The smile we create should be aesthetically appealing and functionally sound requires a comprehensive approach to patient care., improve

communication between the interdisciplinary dental team as well as a laboratory technician, and enhance the treatment outcome. The Digital Smile Design (DSD) is a multi-use conceptual tool that can strengthen diagnostic vision, improve communication, and enhance predictability throughout treatment. The DSD allows for careful analysis of facial and dental characteristics along with any critical factors that may have been overlooked during clinical, photographic, or diagnostic cast based evaluation procedures. The reference lines and shapes are drawn on the computerized photos in a foreordained grouping so that the indicative perception can be broadened and furthermore to help the Dentist for assessing the constraints for a given patient that incorporates any asymmetries and disharmonies<sup>16</sup>

#### DISCUSSION:

The pace at which Digitization is conquering dental practice will revolutionise the future of dentistry<sup>17</sup>. The eventual fate of dental practice is firmly connected to the use of computer based innovation and virtual reality, which permits the dental specialist to simulate genuine true life circumstances in patients. In 'Digitisation' process an image or signal (by scanning, tracing, or a graphics tablet or using an analogue) is converted to digital conversion device. A digital copy or recording is made in this process that might be a document, sound, performance or natural phenomena<sup>17</sup>. There is endless scope of digitisation and technology in Prosthodontics—starting from motivating a patient and maintaining records to making digital impressions<sup>4</sup>, use of digital radiographs and photographs<sup>15</sup>, use of virtual articulators<sup>10</sup> and digital surveyors<sup>13</sup> for planning and fabrication of prosthesis; or for processing of restorations with use of CAD/CAM technology<sup>4,5</sup>, stereolithography, rapid prototyping etc. The applications of above are essential for improving the clinical outcome for the patient.. Research has been enhanced by utilising virtual patient programs, dental soft wares; digital recording of jaw motion, etc. This review has been an attempt to elaborate the digitalization in Prosthodontics. The incorporation of these digital techniques into the dental service could make practice more convenient for both dentist and the patient along with improved treatment outcome.

#### CONCLUSION:

Oral health can be preserved and aesthetics can be greatly enhanced by using the contemporary dental practices which provides endless options along with decreased treatment time, minimized error potential and better quality assurance. These reasons justify the present day dentistry being called golden age of dentistry. Today the dental practitioner needs to be equipped with the latest fast changing technology so as to pose a great challenge.

The literature relating to recent techniques helps us to assimilate latest trends for benefit of patient and for expanding the dental profession as a whole. The transition from old to digital era occurs with the basic aim of making patient's life better

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