International Journal of Science and Research (IJSR)
ISSN: 2319-7064
SJIF (2022): 7.942

Digital Dentistry

Dr. Sukriti Dhanda[1], Dr. Gautam Shetty[2], Dr. Manisha Jain[3]

[1]Under Graduate student, Bhojia dental college and Hospital, Baddi, Solan, Pin - 173205, India

[2]Professor, Department of Prosthodontics Crown and Bridge, Rajarajeswari Dental College and Hospital, Bangalore, Karnataka, Pin - 560074, India

[3]Post Graduate Student, Department of Prosthodontics Crown and Bridge, Rajarajeswari dental college and hospital, Bangalore, Karnataka, Pin - 560074, India

Abstract: ***Digital dentistry has become a part of everyday practice in dental profession. It continues to aid in various fields of dentistry. There has been a lot of developments in diagnosis, treatment plan and materials leading to the success of digital dentistry. There are various technologies used which help diagnosing and planning the treatment digitally, which is dentist - patient friendly and is more comfortable, and is accepted by both dentist and the patient. This article reviews about how digital dentistry is evolving and the future with different kinds of dental softwares are used in dentistry.***

Keywords: Digital dentistry, CAD/CAM, diagnosis.

1. Introduction

With the advancements in technology over all the fields, dentistry has also flourished. In recent years dentists are blending their science with technology to achieve optimum result. Digital dentistry is taking over the conventional in every aspect (diagnosis, treatment plan, execution of the treatment).

Digital technology is a boon to dentistry, as it works effectively and efficiently, reduced working time and number of appointments, dentist - patient friendly, comfortable and easily accepted by the patient, and also gives accurate and better results when compared to other conventional techniques.

It is an aid in various fields of dentistry, like diagnosis, treatment planning, execution of the treatment, and the outcome of the treatment. Basically digital dentistry works on images with scanning devices. These provide dentists with a quick 3D image of a patient's oral or maxillofacial anatomy. It gives a complete 3D image which can be seen in 360°.

Digitalisation of dental records, computer assisted imaging techniques and virtual treatment planning or simulations, have revolutionized clinical practice. Gradually, and almost consecutively, digitalization has been adopted in the three major steps of the conventional patient workflow, resulting in three distinct processes:

1) Digital patient: the acquisition of patient data is digitized (clinical information, x - ray based information or casts) and can now be stored or archived in the patient's digital records
2) Virtual patient: mental planning of the patient's rehabilitation can now be assisted with a digital treatment planning and on - screen simulation (computer - aided design or CAD).
3) Real patient: treatment procedures may be assisted with computeraided manufactured (CAM) devices using milling or 3D printing technology[1]

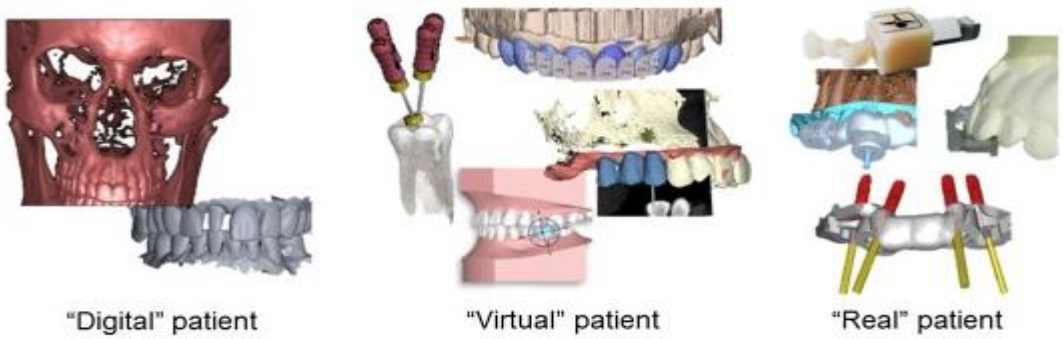

Figure 1

Technologies used in digital dentistry in various procedures.

Diagnosis

A proper diagnosis will lead to a proper treatment planning. Various technologies have been used in digital dentistry for diagnostic purpose - intraoral cameras, intraoral scanners, cone beam computer tomography (CBCT), magnetic resonance imaging (MRI), CT scans, diagnodent (for caries detection).

Intraoral Scanner

An intraoral scanner is a handheld device used to directly create digital impression data of the oral cavity. Recent

technological advancements, e. g., the miniaturization and weight reduction of the wand (scanning tip), scanning - speed enhancement, image - resolution enhancement, and imaging - software improvement, have contributed to establishing a socalled model - less restoration process that does not need operating models. A drastic evolution in dental treatment should be anticipated in the future with the clinical application of these advanced IOSs.2

Types of IOS

Twenty - plus IOS models are commercially available in the world. They are roughly categorized as standalone scanners and all - in - one scanning platforms with CAD/ CAM solutions. The former type of scanner processes the intraoral scanning data into 3D models as image files or completes the prosthetic - appliance design using CAD software so the user can forward the data to the dental laboratory[2] (fig 2).

Figure 2: Standalone scanners systems of CAD/CAM

The latter type, on the other hand, is the socalled "one - day treatment" device, which is capable of immediately designing prosthetic appliances with the 3D model data from the optical - impression obtained by the IOS. The target prosthetic appliance is completed on the same day with a directly connected manufacturing device that cuts and processes the appliance on site with the appropriate materials installed. With proper system construction, a standalone scanner can be an all in - one scanning platform.2 (fig3)

Figure 3: All - in - one scanning platforms with CAD/CAM system.

Cone Beam Computed Tomography

This form of computerized Tomography provides dentists with a quick 3D image of a patient's oral or maxillofacial anatomy. It gives a complete image, which can be viewed in 360 accurate to 1/10th of minimum. We can zoom through tissues to explore the gums, teeth and vital areas like sinuses. The clarity of the image allows us to measure the thickness of the bone and orientation of the nerves. It act as an implant surgical guides for oral surgeons and periodontists when placing dental implants, which in turn makes the treatment accurate than before. Thus it enables to place implants with greater precession and also to diagnose TMJ problems.3

Caries Diagnosis

Diagnodent is designed to aid in early detection of caries by measuring the increased light induced fluorescence. Visual examination and dental explorers help us to find decay on the surfaces of teeth and x - rays show us advanced decay and decay between the teeth. However, these methods don't find decay that's located inside the tooth. So these digital technologies help us to diagnose the hidden decay were the light probe scans the teeth with laser light.3

Computed Tomography

The first commercial computed tomography (CT) scanner was developed in 1972 by Sir Godfrey N. Hounsfield, an engineer at EMI, Great Britain.4 Computed tomography uses a narrow fan - shaped X - ray beam and multiple exposures around an object to reveal its internal structures which helps the clinician to view morphologic features and pathology in three - dimensions[4].

There are four generations of CTs.

1) The Hounsfield's unit belonged to the first generation of CT scanners which used a single detector element to capture beam of X - rays.
2) A second generation of CT systems introduced in 1975 used more than one detector and used small fan - beam, as opposed to pencil - beam scanning in the first generation.
3) Third generation CT scanners introduced in 1976 use a large, arc - shaped detector that acquires an entire projection without the need for translation.
4) Fourth generation scanners replaced the arc - shaped detector with an entire circle of detectors.

Magnetic Resonance Imaging (MRI)

MRI scan is a specialized imaging technique which does not use ionizing radiation. MRI machines are graded on the strength of the magnet, measured in Tesla units. MRI involves the behaviour of hydrogen atoms (consisting of one proton and one electron) within a strong magnetic field which is used to create the MR image. The main dental applications of MRI to date have been the investigation of soft - tissue lesions in salivary glands, TMJ and tumour staging[4].

Treatment planning

After diagnosis, planning of the treatment and execution of the treatment plays an important role. various technologies have been used such as CAD/CAM. CAD/CAM is been used widely in dentistry. It consists an handheld intraoral scanner, a desktop/screen, and a milling machine.

The use of these digital technology have been potentially more advantageous than the conventional as it is easier, faster, and more accurate.

Steps in CAD/CAM

1) Scanners

Digital impressions are a means of recording the shape of patient's dental structures by using scanners. There are contact scanners or non - contact scanners.

Contact scanners use stylus profilometers which are placed against and run along the contours of an object. The contact of the stylus against the object is represented digitally as a set of co - ordinates (point cloud) which is analysed by an onboard mathematical algorithm to build up a 3D image of the object (mesh).

Non - contact scanners capture the shape of dental structures by using optics, such as light - emitting diodes. Light is emitted from the scanner which hits the object and then reflects into an onboard sensor, usually a charge couple device (CCD) or a position sensing detector (PSD). These reflections allow the scanner to build up a 3D image of the object as with contact scanners. Extraoral non - contact scanners can obtain this information by different means, namely: structured light, laser light and confocal microscopy[5].

Scanners in market are
Lava Scan ST (3M ESPE, white light projections
Everest Scan (KaVo, white light projections)
es1 (etkon, laser beam).

2) Design software

CAD software visualises the digital impression captured by extra or intra oral scanners and provides numerous design tools. Popular software packages include Dental System, DentalCAD and CEREC.

The software of CAD/CAM systems presently available on the market is being continuously improved. The latest construction possibilities are continuously available to the user by means of updates. The data of the construction can be stored in various data formats. The basis therefore is often standard transformation language (STL) data[6].

3) Processing devices

The construction data produced with the CAD software are converted into milling strips for the CAM - processing and finally loaded into the milling device[5]. Processing devices are distinguished by means of the number of milling axes:
3 - axis devices.
4 - axis devices.
5 - axis devices

4) Milling variants

a) Dry processing

Dry processing is applied mainly with respect to zirconium oxide blanks with a low degree of pre - sintering. This offers several benefits:

Minimal investment costs for the milling device

No moisture absorption by the die ZrO_2 mould, as a result of which there are no initial drying times for the ZrO_2 frame prior to sintering[6].

b) Wet milling

In this process the milling diamond or carbide cutter is protected by a spray of cool liquid against overheating of the milled material. This kind of processing is necessary for all metals and glass ceramic material in order to avoid damage through heat development. 'Wet' processing is recommended, if zirconium oxide ceramic with a higher degree of pre - sintering is employed for the milling process. A higher degree of pre - sintering results in a reduction of shrinkage factor and enables less sinter distortion[6].

Examples: Everest (KaVo), Zeno 8060 (Wieland - Imes), inLab (Sirona).

5) Materials for CAD/CAM processing

The list of various materials for processing by CAD/CAM devices depends on the respective production system. Some milling devices are specifically designed for the production ZrO_2 frames, others cover the complete palette of materials from resins to glass ceramics and high performance ceramics[6]. The following materials can normally be processed on dental CAD/CAM devices:
Metals
Resin materials
Silica based ceramics
Infiltration ceramics
Oxide high performance ceramics

2. Conclusion

Digital dentistry is growing at an accelerating and it offers unprecedented and wonderful opportunities to improve dental care. The future is digital, with the world making many advancements with technology, CAD/CAM systems will keep evolving and improving as we develop a better understanding of the advantages and limitations of it.7

Conflicts of Interest

The authors declares that there is no conflict of interest regarding the publication of this paper.

Funding Statement

No funding was provided by any institution or external body.

Corresponding author: Dr. Sukriti Dhanda, Under Graduate student, Bhojia dental college and Hospital, Baddi, Solan, Pin - 173205, India

References

[1] Anuradha B, Mensudar R, Venkatesh A, Mary GP, Pravalikka P. International Journal of Medicine and Health Profession Research.
[2] Suese K. Progress in digital dentistry: The practical use of intraoral scanners. Dental Materials Journal.2020 Jan 30; 39 (1): 52 - 6.

[3] Vandenberghe B. The digital patient–Imaging science in dentistry. Journal of dentistry.2018 Jul 1; 74: S21 - 6.
[4] Shah N, Bansal N, Logani A. Recent advances in imaging technologies in dentistry. World journal of radiology.2014 Oct 10; 6 (10): 794.
[5] Davidowitz G, Kotick PG. The use of CAD/CAM in dentistry. Dental Clinics.2011 Jul 1; 55 (3): 559 - 70.
[6] BeuerJ F. SchweigerD. Edelhoff, ". Digital dentistry: an overview of recent developments for CAD/CAM generated restorations.: 505 - 11.
[7] 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): 1 - 1.