

Digitization In Conservative Dentistry And Endodontics: A Review

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Abstract

Technology and dentistry have combined to produce amazing results. To attain the maximum success rates, the patient's needs and technology have been weaved together. For the dentist, the assistant, and the patient, it offers a number of benefits. Technology has not only uplifted the accuracy and intricacy of dentistry but has reduced the burden on the clinician as well. Traditionally, with only two-dimensional X-ray data available, establishing correct diagnosis and an appropriate treatment plan could be arduous; therapies essentially relied on the manual skills and experience of the operator. But now, Digitalisation comes with bounty of blessings. The speed and simplicity of procedures, which means the patients can be in and out of the clinic with their teeth completely restored in way less time than with conventional techniques.

Keywords: Digital Dentistry, Caries, CAD/CAM, Apex Locators, Pulp Testers, Guided Endodontics

INTRODUCTION

Digital technologies have revolutionized many branches of health sciences, one of which is dentistry. This new era has curated various technologies that combine documentation, education, manufacture, and delivery of dental treatment, all computer-assisted. These technologies have not only improved dentistry's accuracy and complexity but also reduced many hardships for the dentist. Digital dentistry may be defined as the use of any dental-related technology or device that is built-in digital or computer-controlled elements rather than operated electrically or mechanically alone.¹ Temporisation and multiple-visit appointments are a thing of the past now. The speed and simplicity of digital technology have made it possible for patients to move in and out of the clinic with complete treatment in much lesser time compared to conventional techniques. This article provides an understanding of the various aspects of dental treatment that have reaped digital technology's benefits.

(A) IN OPERATIVE DENTISTRY

(a) Caries Detection

The traditional caries detection systems gave limited information for early detection of non-cavitated lesions; however, accurate quantification and detection of lesions in the initial stages is now offered by newer novel diagnostic systems. These systems work on the physical signals that include electronic current, x-rays, lasers, visible light, and ultrasound.² Methods of different caries detection based on their underlying principles is mentioned in table 1.¹

Table 1: Methods Of Different Caries Detection Based On Their Underlying Principles

Medium of Energy Source	Clinical Applications
X-rays	Digital subtraction radiography Digital image enhancement
Visible light	Fibre optic transillumination (FOTI) Diode laser fluorescence (DLF) Digital imaging fibre optic transillumination (DIFOTI)
Laser light	Laser fluorescence measurement (DIAGNOdent)
Electrical current	Electrical conductance measurement (ECM)
Ultrasound	Ultrasonic caries detector

(b) CAD/CAM

In dentistry, CAD/CAM technology has ushered in a new era. The CAD/CAM concept was introduced into dentistry by Dr. Francois Duret in the year 1973. He later developed and patented the CAD/CAM device in the year 1984.¹ A CAD/CAM system is composed of 3 stages of data acquisition, data processing, and machining.³ These production processes have significantly upgraded the quality of dental prostheses, increased productivity drastically, and have changed dental laboratories from manufacturers to modern computerized production units. Using CAD/CAM technology, it is now possible to use new materials like high-performance ceramics and titanium with high accuracy and intricacy.⁴ The presently available software of CAD/CAM systems on the market is being constantly improved. The latest construction possibilities are continuously available to the user at the touch of their fingers with new updates. The storage of this data can be in various formats and forms. The basis, therefore, is often standard transformation language (STL) data.⁵

(B) IN ENDODONTICS

Since the turn of the century, various advancements in endodontic technologies have allowed dentists to see what we could not see before. These include:

(a) Pulp Testers

According to recent research, blood circulation—rather than innervations—is the best indicator of pulp viability since it can objectively distinguish between necrotic and viable pulp tissue.⁶ Vitality pulp tests are used to evaluate a number of characteristics of the dental pulp's vascular supply, which is the true indicator of the pulp's vitality. Laser Doppler flowmetry, Transmitted laser light, Laser speckle imaging, Pulse oximetry, Transmitted light plethysmography, and Dual wavelength spectrophotometry are pulp testing methods based on optical technology.⁷ They are absolutely painless, non-invasive, and objective (require no subjective response from the patient).⁸ One of the limitations of all light-transmitting instruments used for pulp testing is that they are only applicable to teeth having pulp tissue present in the coronal portion of the tooth.⁹ Pulse Oximetry and Laser Doppler Flowmetry are the most studied vitality pulp tests, with the best clinical results among the pulp testing methods.¹⁰ Transmitted Light Plethysmography and Transmitted Laser Light were developed for pulp testing in an attempt to improve some of the limitations of Pulse Oximetry and Laser Doppler Flowmetry, respectively, but with relative success, as they come with limitations of their own.¹¹

(b) Apex Locators

Apex locator is defined as an electronic endodontic device used to determine the length of the root canal space more accurate, precise, and predictably by determining the position of the apical constriction, which has been found to have an electric resistance of 6.5 kilo ohms (k Ω), and this specific characteristic was behind the development of apex locators. The principle of apex locator is based on the electrical resistance of different tissues. The electrical resistance value between the periodontal ligament and the oral mucosa was found to be constant (6.5 k Ω).¹² A direct electrical current of a known voltage is produced by the apex locator, which passes through the endodontic file and is recaptured back by a metal hook. The circuit is complete when the tip of the file reaches the periodontal ligament, which then displays a "0" value on its screen. The latest and sixth generation, also known as adaptive apex locators, use multifrequency technology. They work accurately in both dry and wet conditions, even with the presence of exudates or blood.¹³ It can continuously adapt to the level of humidity in the root canal.¹⁴ Furthermore, the devices can produce different kinds of sound to indicate the progress of the file in the root canal. Raypex® 6 Apex Locator (VDW) and ProPex Pixi (Dentsply, USA) are examples of this generation.

(c) Sonic & Ultrasonic

The term endosonics (Ultrasonics in endodontics) was first coined by Martin and Cunningham.¹⁵ Ultrasonic in endodontics is mainly used for access preparation and refinement of root canals, root-end cavity preparation and refinement, removal of intra-canal obstructions such as broken instruments and posts, retrograde filling, passive irrigation, and needle activation during sonic or ultrasonic irrigation (active irrigation). Passive irrigation is conducted by slowly dispensing the root canal irrigating solution through different gauged needles.¹⁶ The needle should be loose in the canal to allow the irrigant to reflux and move the debris coronally. Similarly, to achieve deeper and more effective placement, smaller gauged needles must be chosen. The advantage of active irrigation over passive irrigation is that it initiates dynamics and flow within the fluid and thus improves disinfection of the root canal.

(d) Delivery of Local Anaesthesia

It is crucial to control the pain and anxiety of the patient during an endodontic procedure. A variety of different injecting devices that do not require the usage of a needle have been developed, such as Iontophoresis, Computer-controlled local anaesthetic delivery (CCLAD), The Wand™, Single Tooth Anaesthesia (STA), The Comfort Control Syringe. These devices help in delivering anaesthesia in a slow, painless manner, thereby increasing comfort and reducing tissue damage as compared to the traditional syringe.

(e) Endodontic Electric Motors

Automated instrumentation systems (Endodontic electric motors) are devices developed to improve the speed efficiency of the endodontic process by allowing the use of mechanically driven instruments.¹⁷ A new generation of low

torque control motors (known as endodontic motors) has been developed to improve root canal preparation using NiTi instruments. The new generation of motors has incorporated many valuable features, including the small size, lightweight, and the ability to produce both high and low speed with less noise and vibration (i.e., StarETorque, DentalEZ). Three mode motions are available in some recent endodontic motors, which are continuous, reciprocating, and non-continuous motions. Currently, the Wave One motor (Dentsply Maillefer, Switzerland) provides asymmetric motion of 150°CCW and 30°CW, and the VDW Silver Reciproc motor (VDW, Munich, Germany) provides a similar motion of 170°CCW and 50°CW. In these motors, three reciprocating cycles complete one complete reverse rotation, which allows the rotary file to gradually advance into the canal with less apical pressure. The optimum torque reverse (OTR) function is another function that was added to a new generation of endodontic motors (DentaPort ZX OTR). The main purpose of this is to prevent file jamming inside the root canal. Recently endodontic motors with an integrated electronic apex locator are being widely used. Along with the length measurement function, these devices also have torque control and speed settings (X-Smart Dual)

(f) Obturation

Recent wireless devices such as DownPak (EI, Hu-Friedy, Chicago, IL) or the Endotec II (Medidenta International Inc.; Woodside, NY) are battery operated and allow convenience during the obturation technique. It utilizes heat and vibration for vertical and lateral condensation, thereby minimizing the need for high temperatures during obturation. The Obtura 3 (Obtura), Calamus (Tulsa, Dentsply), Ultrafil 3D (Hygienic- Coltene-Whaledent, Akron, OH) are the most commonly used devices for thermoplasticized gutta-percha. To assure better compaction of gutta-percha, this technique requires vertical compaction between increments. Many companies have introduced integrated devices that contain handpieces for down pack and backfill (flow) techniques (Calamus Dual, Dentsply Tulsa Dent Specialties; Elements obturation Unit, Kerr). Carrier-based technique is another heat-based obturation technique that consists of a carrier coated in with GP. These carriers are manufactured from plastic (Thermafil, Dentsply-Tulsa Dental) or cross-linked GP (Gutta Core, Dentsply Maillefer, Ballaigues, Switzerland). When choosing an obturation technique, certain variables should be taken into consideration, such as root canal anatomy, the type of sealer used, and the residual microbial irritants in the canal.

(g) Surgical Operating Microscope

Using a surgical operating microscope (SOM) in endodontics was suggested in the early 1990s. The device was ergonomic, provided five magnifications (3.5× to 30×), and had some documentation accessories. Currently, there are many brands, multiple models, and different generations with more improvements in the market. Regardless of the brand and the generation, SOM contains four main components:

1. Body of microscope
2. Light source housing
3. Supporting structures
4. Documentation components

SOM provides magnification and intense illumination, which definitely improves performance in endodontics and provides many advantages as it helps to¹⁸

1. Improve ergonomics for the clinician.
2. Prepare optimal access cavity.
3. Preserve more tooth structure.
4. Find hidden and accessory canals
5. Negotiate calcified canals.
6. Locate and retrieve separated instruments

(h) 3D Guided Endodontics

When preparing the access cavity, the idea of “Minimally Invasive Endodontics” should be taken into account. It is always best to avoid the removal of unnecessary tooth structure.¹⁹ New conservative (contracted) access cavities and ultraconservative (ninja) access cavities were developed to preserve more dental tissue.²⁰ The preparation of conservative access can be difficult in various clinical situations. For example, in the case of teeth with calcified coronal pulp chamber (pulp stone) or sclerosed canals, the calcific deposits might cover the orifices of root canals or block the canal spaces. One of the trickiest techniques in dentistry is the endodontic treatment of such teeth. More recently, a revolutionary method to treat teeth with calcified pulp canals and apical disease called “Guided Endodontics” has been launched.²¹ The idea behind this novel method is to create an accurate access cavity by creating a computer-aided guide using computed tomographic data. In order to perform guided endodontics, volumetric data from CBCT and surface scan data from an intraoral scanner must be obtained. In computer-aided design (CAD) software, both sets of data are layered for planning a virtual access cavity and creating a template. After that, the template is created using 3D printing, and drills are used to prepare the cavity.²²

DIGITAL SMILE DESIGN

One of the cornerstones of dentistry, aesthetics, has always been a part of the pursuit of better results. Since the past decade, smile analysis and design have received significant attention in dentistry, necessitating a comprehensive approach to patient treatment. From the first generation, when hand drawing on printed photos of the patient was used to communicate and explain the final outcome, it has now progressed into complete digital drawing on DSD software on a computer. DSD is a technical tool that is used to design and modify the smile of patients digitally and help them to visualize it beforehand by creating and presenting a digital mock-up of their new smile design before the treatment physically starts. Coachman and Calamita described DSD as a multi-use conceptual tool that can support diagnostic vision, improve communication, and enhance treatment predictability by permitting careful analysis of the patient's facial and dental characteristics that may have gone unnoticed by clinical, photographic, or diagnostic cast-based evaluation procedures.²³DSD technique is carried out by digital equipment already prevailing in current dental practice like a computer with one of the DSD software, a digital SLR camera, or even a smartphone.²⁴ A digital intra-oral scanner²⁵ for digital impression, a 3D printer, and CAD/CAM are additional tools for complete digital 3D workflow.

Types of DSD software

1. Photoshop CS6 (Adobe Systems Incorporated)
2. Microsoft PowerPoint (Microsoft Office, Microsoft, Redmond, Washington, USA)
3. Aesthetic Digital Smile Design (ADSD - Dr. Valerio Bini)
4. PlanmecaRomexis Smile Design (PRSD) (PlanmecaRomexis@)
5. Keynote (iWork, Apple, Cupertino, California, USA)
6. ExocadDentalCAD 2.3

It has several advantages like it enhances the predictability of the treatment by assisting patients in visualizing the desired outcome before the start of the actual treatment.²⁶It enhances clinical diagnosis and treatment plan by providing an aesthetically pleasing representation of the patient's issue through digital analysis of facial, gingival, and dental factors. Customizing smile designs by involving patients more actively results in a more visually pleasing, humanistic, emotive, and self-assured smile.²⁷Enhances communication not just between the doctor and the patient but also between the members of the interdisciplinary team, clinicians, and the lab technician.

CONCLUSION

In conclusion, digital dentistry has a promising future and a wide range of applications. For better outcomes, ongoing and future research should be combined with clinical practice. However, digital smart data technology should not be seen as a threat to people or their ability to empathize with patients. However, in order to provide patients with better and more affordable healthcare, the advantages of digital applications will complement human qualities and talents.

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