Digital Dentistry: The Impact of Technology on the Diagnosis and Treatment of Dental Diseases

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Abstract

Dentistry has undergone a gradual shift towards digitalization since the 1970s, beginning with the introduction of computed tomography in the 1970s. The most notable transformations in the field have been the introduction of digital workflow and computer-aided manufacturing (CAM), which have enabled the use of new procedures and materials that were previously unavailable. Unlike traditional laboratory workflows that rely on light or chemical curing under unstable conditions, CAM allows the use of high-quality prosthetic materials, ensuring the sustainability and quality of materials over time. In addition to these fundamental transformations, several innovative approaches have been developed in digital dentistry that impact or will impact prevention, diagnosis, and treatment. These technologies contribute to improving oral health and patients' oral health-related quality of life. Both software and hardware enhance the ability to maintain, restore, or improve oral health, which positively impacts patients' lives by improving treatment outcomes and reducing suffering. This article reviews the latest innovations in digital dentistry and their potential impact on patients' oral health-related quality of life, with a focus on prevention and treatment. The article also discusses potential future developments in this field and their potential impact on dental care and patients' quality of life.

Keywords: Dentist, Digital dentistry, CAD-CAM, 3D printers, The Wand, Diagnodent.

1. Introduction

Our current era is characterized by digital transformation in all fields and specialties. Dentistry is witnessing a rapid transformation in the use of digital technology, and with the advancement

of modern tools and techniques used in dentistry, it has led to improved treatment methods, improved oral and dental health, and saved time and effort [1].

Traditional methods used in dentistry, such as detecting caries lesions, making dental models, taking dental impressions, and assembling dentures, consume time and effort, and increase treatment costs [2]. Recently, with the introduction and use of various and multiple digital technologies in the field of dentistry, such as digital radiology, oral scanners, computer-aided design (CAD) / computer-aided manufacturing (CAM), and 3D printers, a huge revolution and transformation in dental treatment have occurred [1,3].

The benefits of digital dentistry are evident in the accuracy of diagnosis and thus the development of effective treatment plans. Digital radiology technology and cone beam computed tomography (CBCT) provide accurate, detailed and precise cross-sectional images of oral tissues, gums and teeth, which contribute to the development of accurate and predictable treatment plans [4]. In addition to the speed and efficiency of dental treatment provided by digital technologies. In addition, CAD/CAM technologies contribute to the completion of dental restorations in a single session with accuracy and efficiency compared to traditional methods that require multiple visits and temporary procedures to restore teeth. The use of digital dentures also enhances accuracy and comfort and reduces the need for traditional materials that may be uncomfortable for some patients [5]. These technologies also contribute to improving the sustainability of treatment and reducing waste and resources used, making digital dentures an environmentally friendly option compared to traditional methods [6].

Digital dentistry offers effective treatment options that maintain oral and dental health and provide greater comfort to patients than traditional dentistry. Digital technology contributes to enabling dentists to increase diagnostic accuracy and reduce surgical intervention, making treatment more effective [6]. This technological advancement has led to a fundamental shift in the way dental treatments are provided, from 3D imaging technologies to oral scanners that replace traditional materials for making dental impressions, which enhance efficiency and patient satisfaction [7]. The benefits of digital technologies in dentistry are endless. Therefore, this review aims to study the effects of these digital transformations on patients' oral health-related quality of life (OHRQoL) by reviewing modern digital technologies in dentistry.

Digital Dentistry

Digital dentistry dates to the 1970s, when dental restorations were made using ceramic instead of metal. With the advancement of digital technology in dentistry, computer-aided design/computer-aided manufacturing (CAD/CAM) has been introduced, which has led to dramatic changes in the materials used and their diversity, making them available and suitable for dentistry and improving oral and dental health [8]. Digital dentistry is the use and employment of diagnostic and therapeutic techniques that include computer processing of data in their various parts, meaning that computers and the digital structure of the technology in this field of dentistry are an essential part of the technology used. The introduction of software and other medical imaging tools has led to many benefits such as improved workflow, communication between practitioners and patients, material selection, and clinical outcomes [9]. Most digital technologies start as stand-alone solutions but will be implemented in more comprehensive digital networks soon after. The use of digital technologies in dentistry has led

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to significant development in its fields in terms of the speed of completing therapeutic and cosmetic procedures, the quality of results, and providing various methods for performing the medical procedure. Digital dentistry and the development of technical means in dental treatment also contribute to increasing the level of safety in medical procedures and reducing the risk of complications [10]. However, we must distinguish between the effects of digitization and artificial intelligence. Artificial intelligence is a logical part of digitization that uses algorithms and machine learning to automate tasks that traditionally require human intelligence [11].

Types of digital dentistry

Digital dentistry is changing all aspects of oral health care, from diagnosis to treatment. Digital dentistry also makes it easier for the dentist to follow up with his patient and monitor the progress of the treatment case. Digital dentistry includes any digital or computer-based technology that dentists use to investigate, diagnose and treat dental problems, including:

1.   Intraoral Cameras:

Intraoral cameras are small cameras used by the dentist to view and examine the oral cavity, teeth and gums. They replace the small hand-held mirror that is traditionally used. The best feature of this technology is the magnification of the image [12]. Intraoral cameras allow the image to be displayed on a screen at a higher magnification for a closer examination of the teeth. The dentist can diagnose potential oral health problems more easily and accurately. This technology also allows the image to be shared with the patient, which enables the patient to better understand their condition in order to improve their oral hygiene and oral health care [13]. The dentist can also share the images with the laboratory technician in order to better match crowns and bridges to the patient's teeth [14].

2.   Digital Radiography

Digital radiography is a diagnostic method that uses x-rays to take a patient and display the images digitally on a screen after processing them using a computer. Digital radiography is an advanced version of traditional radiography, which requires the use of film and takes a long time to process the image. It is also more expensive than digital radiography, in addition to the need to keep the printouts on paper, the need for a place to store them, and the need to hand them over when needed to share them with another doctor or laboratory technician. While image processing on the computer is faster in digital radiography, it is less expensive, easier to store, and can be shared easily and quickly [15]. Exposure to radiation in digital radiography is less than exposure to radiation in traditional imaging [16].

3.   Computer-Aided-Design and Computer-Aided-Manufacturing (CAD/CAM)

CAD/CAM refers to a technology known as computer-aided-design and computer-aided-manufacturing, which is a technology with many therapeutic applications in the field of dentistry. CAD/CAM technology in dentistry includes designing dental prosthetics using a computer in order to improve their design and quality. It is widely used in the manufacture of artificial teeth such as dental crowns and fixed dental bridges, in the manufacture of veneers as well as in the design and manufacture of dental implants, as well as removable and fixed dentures, as well as removable and fixed braces [17]. CAD/CAM technology has contributed significantly to the development of the field of dental prosthetics and fixtures, increasing the efficiency of artificial teeth, extending their life, improving the design of fixtures, and obtaining more harmonious and compatible shapes with the mouth and teeth [5]. CAD/CAM technology can also be used to make dental impressions instead of the traditional method that is difficult and annoying for the patient,

such as making dental impressions using CAD/CAM technology is more timesaving and provides more accurate and higher-quality impressions [17].

4.   3D Printing

3D printing contributes significantly to the development of manufacturing around the world, and it is also one of the important and very useful tools in dental treatment and in the field of digital dentistry. 3D printing technology is based on the principle of designing parts or tools computer-based and then adding them algorithmically to the 3D printer, which manufactures the design using raw materials that are placed in the printer in advance. 3D printing is useful in the field of dentistry in manufacturing dentures and various dental prosthetics such as bridges, crowns and veneers. It is also possible to rely on 3D printing to manufacture dental implants in their various shapes, and various types of braces can also be manufactured using this technology. 3D printing provides great accuracy in design, great durability and quality as well. The designs of dental prosthetics in 3D printing are also characterized by their great compatibility with the structure and shape of the mouth and natural teeth, which increases the ease of installing the prosthetics and increases the likelihood of their success and extends their life. It is also a means of saving resource consumption and reducing the raw materials needed to obtain the desired design compared to other design methods [18,19].

5.   CT scans

Computed tomography is used in dentistry to diagnose jawbone diseases and determine the location and extent of the injury in a manner similar to the method used in magnetic resonance imaging. Computed tomography can also be used to study the sinuses and oral cavity and to study the alveolar bone when installing dental implants in order to determine the method of installing dental implants and the appropriate position for placing the humps. A newer method than computed tomography has appeared later and is more useful in the field of digital dentistry, which is cone beam computed tomography. It is a less expensive technique than traditional computed tomography, and exposure to radiation during imaging with this technique is less. It is a technique with great effectiveness and accuracy in clarifying and studying the features of the mouth, teeth and jawbones. Cone beam computed tomography (CBCT) is also very useful when placing dental implants and in cases of wisdom tooth extraction [20].

6.   Computer-Aided Implant Dentistry

In computer-aided implant dentistry, a surgical scanning system of the jawbone is used. This system electronically reproduces the implant locations, creating a computerized copy that is identical to the actual location of the implant. In this way, the dentist can obtain better, more efficient and high-quality dental implants that are more compatible with the jawbone. Although this technology is not widely used yet, it is more accurate than traditional dental implants, faster to complete, and has better long-term results in dental implants in terms of the stability, durability, and lifespan of the implanted teeth [21].

7.   Shade matching

When manufacturing dental prosthetics such as bridges and crowns, the color of the manufactured implants must be matched with the color of the natural teeth in order to achieve harmony between the natural teeth and the dental implants. Shade matching of the implants is performed using several traditional methods, and various imaging methods can also be used to achieve a very good match in the color of the teeth between the natural teeth and the color of the implants. Digital imaging is being used recently to obtain a high-quality match in the color of

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the teeth, as a digital camera is used with a coupling device that allows images to be saved and shared with the laboratory technician and added to the patient's file. Digital images are useful in providing accurate data for use in determining the appropriate shade of the teeth digitally. Also, the dental implants must be designed computer-based and the shade itself selected and then the design implemented. In this way, a very high match in the color of the dental implants with the color of the natural teeth can be obtained [22].

8.   Diagnodent

Diagnodent is a modern technology introduced in recent years, and Diagnodent has revolutionized the field of dentistry and treatment and the diagnosis of caries and tooth decay. Diagnodent is used to diagnose dental cavities and find dental caries and tooth decay. It is a device that uses diode technology and laser beam to examine the patient's teeth. The laser source is focused on the teeth and the laser scans the teeth, then digitally processes the data and presents it to the doctor in the form of visual information that the doctor can rely on to diagnose and find the smallest cavities in the teeth. Thus, the Diagnodent device provides the ability to diagnose dental cavities in their early stages and treat them before they grow and cause dental problems. Also, treatment in the case of early detection of cavities is easier and fillings are simpler and smaller. Diagnodent also uses light energy without resorting to rays, so it is a completely safe diagnostic method for the patient [23].

9.   The Wand - Used in Local Anesthesia

The Wand is a computerized device that injects local anesthetic into the patient in the area surrounding a tooth that needs treatment without the patient feeling any pain from the needle. The Wand is radically different from traditional medical syringes. It is a portable pen-like device that injects the local anesthetic slowly and gently so that the patient does not feel the pain from the needle, unlike traditional local anesthesia using a regular medical syringe. The Wand is an excellent technology for use on patients who suffer from phobias and nervousness and are afraid of dental injections. It is also safe and easy for the doctor to use and provides the same degree of anesthesia compared to traditional local anesthesia [24].

Uses of digital dentistry.

Digital dentistry has many and varied uses, as it includes a wide range of medical procedures that can be used.

1. In restorative dentistry: Digital dentistry can be widely used in restorative dentistry, as it is possible to take high-quality images with very precise details and study the anatomical structure of the area targeted for treatment, as well as study the bones, teeth and gums using various imaging techniques. All types of dental prosthetics can be manufactured, such as crowns, bridges, dental implants, dentures and all prosthetic supplies that the doctor needs to restore teeth [25].

2. In orthodontics: Digital dentistry techniques greatly facilitate orthodontic procedures, as they are useful in taking digital impressions of the teeth and processing them, as well as manufacturing the appropriate shape of the braces digitally and using CAD CAM and 3D printing techniques in manufacturing the design and applying it to the teeth so that it achieves the best results and the highest quality and accuracy in the shortest possible time and with less effort and cost as well [26].

3. In orthopedic and cranial surgery: Computed tomography, magnetic resonance imaging and various X-ray imaging techniques are mainly used in orthopedic and cranial surgery. Computed

tomography and magnetic resonance imaging provide a comprehensive scan of the entire skull, bones, sinuses and nervous system. These techniques provide the doctor with many details about the shape and position of the bones and are useful in determining the most appropriate and effective treatment method as well [27].

2. Conclusion

Digital dentistry is revolutionizing the world of dental health care. Dental clinics around the world are becoming more efficient. As a result, both patients and dentists benefit from improved methods and highly advanced tools. The entire experience has become highly interactive and engaging for patients thanks to technology.

It is no longer just the dentist who can see what is inside a patient's mouth, but patients can also see their dental problems. This enhances the process of performing procedures and improves their health. Advanced technologies also allow patients to spend less time in the dental clinic, which reduces the cost of treatment as well. Diagnosis has become faster thanks to the use of digital X-rays in examinations. All of this leads to better patient experience, especially for anxious patients who do not want to be treated using traditional treatment methods.

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