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Literature Review

Ethical and legal aspect of digital dentistry in conservative dental practice

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ABSTRACT

Background: *The dental profession began to use digital dentistry on a daily basis. The ethical and legal issues associated with incorporating this technology into routine dental practice have not received enough attention, despite the large number of publications on digital dentistry. This study aimed to assess the ethical and legal impacts of digital dentistry technology on both dentists and patients. There was also discussion of the difficulties associated with the virtual patient and telemedicine.* ***Purpose:*** *to systematically examine and analyze the ethical and legal implications of digital technology into conservative dental practice.* ***Reviews:*** *Digital dentistry has several advantages, including increased diagnostic accuracy, better treatment results, and higher patient satisfaction, it also poses substantial ethical and legal aspect. This review examines patient confidentiality, data protection, informed consent, digital dental device safety, and tele-dentistry regulation. This review give a complete overview of the ethical and legal aspect surrounding digital dentistry by integrating current research and regulatory requirements, therefore guiding best practices and policy in conservative dental practices.* ***Conclusion:*** *Digital dentistry offers significant benefits to dental practices, including improved diagnostic accuracy, treatment outcomes, and patient satisfaction. However, dentists must address ethical and legal concerns like informed consent, patient data protection, and access to advanced technology. Regular evaluations through patient feedback and clinical audits are necessary to optimize these benefits. Additionally, dentists must educate patients on oral hygiene and advance dental technology, ensuring safe, high-quality dental care in the digital era.*

Keywords: *ethical; legal aspect; digital dentistry; dental practice, conservative dentistry.*

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INTRODUCTION

The advancement of digital technology has significantly impacted various fields, including dentistry. The digitalization of dental practice has introduced advanced technologies such as intraoral scanners, digital imaging, CAD/CAM restorations, and Electronic Health Records (EHR) systems.[1] These innovations not only enhance the accuracy and efficacy of diagnostic and treatment but also bring forth ethical and legal challenges which need to be addressed to ensure safe and effective practice.[2,3] The application of digital technology in conservative dental practice offers significant benefits. For example, intraoral scanners allow for accurate imaging of teeth and soft tissues, improving the quality of restorative treatment.[4] Digital imaging, such as Cone Beam Computed Tomography (CBCT), provides better visualization of anatomical structures, enabling more precise diagnoses and efficient treatment planning. However, the use of these technologies also raises questions about patient data protection and the integrity of digitally stored medical information.[5]

Informed consent is a crucial component of medical practice, ensuring that patients are adequately informed about the procedures to be performed, including their risks and benefits. In the context of digital technology, this information must include explanations of how patient data will be used and protected. Lack of clarity in conveying this information can lead to serious legal and ethical issues.[3] Increasing use of EHR and other digital technologies, patient data protection has become a major issue. Electronic patient management systems must be designed with strict security measures to prevent data breaches and unauthorized access.[6] Privacy violations can have serious legal consequences for dental practitioners and erode patient trust.[7]

Digital technology offers great potential to improve the quality of dental care. However, it is important to ensure that this technology is used correctly and in accordance with established standards. Errors in the use of digital technology

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can result in misdiagnosis or ineffective treatment, which in turn can lead to legal claims. Therefore, ongoing training and supervision are essential.[4] Different countries have regulations governing the use of digital medical devices in dentistry. These regulations aim to ensure that the devices used have been tested and approved for safety. In addition, professional dental associations also issue guidelines and practice standards that practitioners must follow.[8]

In cases of misdiagnosis or treatment errors caused by digital technology, legal liability becomes a major issue. Dental practitioners must understand the legal implications of using this technology and ensure they are adequately covered by malpractice insurance. The procedures for handling malpractice must be clear and transparent.[7] Dental practitioners have a responsibility to use digital technology ethically and in accordance with professional standards.[4] They also have the right to receive adequate training and access to the latest technology to improve the quality of care. Balancing these rights and responsibilities is essential to maintaining professional integrity and patient trust.[2]

Case studies from conservative practices successfully using digital technology can provide valuable insights into the benefits and challenges faced. Positive patient experiences and treatment outcomes can support the broader adoption of this technology.[9] However, it is also important to study relevant legal cases to understand the risks involved. Adoption of digital technology gives rise to a number of problems and debates, such as concerns about accessibility, cost, and the morality of using new technologies.[10] For conservative dentistry practices to successfully use digital technology, it is imperative to recognize and tackle these obstacles.[11]

METHODS

An article search in English was conducted, through PUBMED database to identify studies about legal aspects, digital dentistry, conservative dental practice published from 2015 to 2023. The keywords searched are digital dentistry, legal aspect, conservative dentistry, and dental practice. The information collected was obtained from secondary data of previously published studies.

RESULTS

Implementation of Digital Dentistry in Conservative Dental Practice

The adoption of digital dentistry in conservative dental practice offers many benefits, including enhanced treatment outcomes, improved diagnostic accuracy, and increased patient satisfaction.[9,12] Digital technologies enable precise and minimally invasive treatments, preserving more of the natural tooth structure and promoting better oral health.[13] Additionally, digital workflows streamline dental procedures, reducing chair time and enhancing overall practice efficiency.[14]

Digital Imaging

Digital imaging technologies, such as digital radiography and Cone Beam Computed Tomography (CBCT), have significantly improved diagnostic accuracy in conservative dental practice.[15] Comparing digital radiography to traditional film radiography, the former provides greater resolution pictures at lower radiation doses.[16] Three-dimensional imaging is provided by CBCT, which helps with accurate diagnosis and treatment planning by enabling thorough viewing of tooth structures.[17] These advancements facilitate early detection and management of dental caries and other oral pathologies, ultimately improving patient outcomes. [18]

Intraoral Scanners and Impressions

Intraoral scanners have revolutionized the process of taking dental impressions. These devices capture precise digital images of the dental arches, eliminating the need for traditional impression materials that can be uncomfortable for patients.[19] The digital impressions obtained can be used for designing and fabricating restorations such as crowns, bridges, and veneers with high accuracy and reduced turnaround time. This technology not only enhances the quality of restorations but also improves patient comfort and satisfaction.[20,21]

CAD/CAM Technology

Computer-Aided Design and Computer-Aided Manufacturing (CAD/CAM) technology has become an integral part of conservative dental practice. CAD/CAM systems allow for the design and fabrication of dental restorations in a single visit, reducing the need for multiple appointments and temporary restorations. This technology ensures high precision and customization of restorations, leading to better fit and function. Additionally, CAD/CAM technology streamlines the workflow in dental clinics, improving efficiency and productivity.[22]

Digital Smile Design (DSD)

Aesthetics, one of the main pillars of dentistry, has long been involved in the search for improved outcomes.[23] In the last 10 years, smile analysis and design have drawn a lot of attention in dentistry, which calls for a thorough approach to patient care. Comprehensive digital drawing using DSD software on a computer has replaced hand sketching on printed images of the patient, which was utilized in the initial generation to convey and explain the conclusion. Through the creation and presentation of a digital mock-up of the new smile design prior to the actual commencement of treatment, DSD is a tool which helps patients virtually design and adjust their smiles. Coachman and Calamita defined DSD as a multiuse constructing tool which improve communication, support diagnostic vision, and improve treatment predictability by allowing careful analysis of the patient's dental and facial characteristics that may be unnoticed by photographic, clinical, or diagnostic cast model-based assessment procedures.[20]

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Pulp Test

Based on objective differentiation between necrotic and viable pulp tissue, blood circulation is a better sign of pulp viability than innervations, according to current study. The vascular supply of the dental pulp, which is the real measure of the pulp's vitality, is assessed using a variety of features by vitality pulp tests. The following optical-based pulp testing techniques are available: pulse oximetry, transmitted light plethysmography, laser speckle imaging, laser Doppler flowmetry, and dual wavelength spectrophotometry. They are completely painless, non-invasive, and objective (don't need the patient to provide a subjective answer).[24] The fact that all light-transmitting devices used for pulp testing can only be utilized on teeth when pulp tissue is present in the coronal section of the tooth is one of their limitations.[9]

Apex Locator

Apex locator is an electronic endodontic device with function to determine the root canal length more precisely, accurately, and predictably by determining the position of the apical constriction, which have an electrical resistance, and this detailed characteristic was the reasoning behind the development of apex locators. The basic principle of apex locator is using the electrical resistance of diverse tissues. The electric resistance value between the oral mucosa and the periodontal ligament was found to be constant. Through the endodontic file, the apex locator generates a direct electrical current of a defined voltage, which is then collected again by a metal hook. Using multifrequency technology, the most recent and sixth generation locators are also referred to as adaptive apex locators. Even when there are exudates or blood present, they function accurately in both wet and dry environments. It is constantly able to adjust to the humidity inside the root canal. Additionally, these devices can produce different kinds of sound to inform the file progression in the root canal.[25]

Endodontic Electronic Motors

Endodontic electric motors (automated instrumentation systems) are devices developed to increase the time efficiency of the endodontic treatment procedure by allowing the use of mechanically driven instruments. By permitting the use of mechanically powered tools, automated instrumentation systems, also known as endodontic electric motors, are devices designed to increase the speed and efficiency of the endodontic procedure. Using the application of NiTi tools, a new generation of low torque control motors, or endodontic motors, has been created to enhance root canal preparation. Many useful characteristics have been added to the current generation of motors (e.g., StarETorque, DentalEZ), which can operate at both high and low speeds with less noise and vibration. They are also lightweight and compact in size. Certain modern endodontic motors have three modes of motion: reciprocating, continuous, and non-continuous.[9]

3D Guided Endodontic

The concept of "Minimally Invasive Endodontics" needs to be considered when preparing the access cavity. It is always preferable to refrain from removing unneeded dental structure. To conserve more dental tissue, new ultraconservative and conservative access cavities were created. In many clinical circumstances, the preparation of conservative access might be challenging.[24] For instance, calcific deposits may obstruct or cover the root canal orifices in teeth with sclerosed canals or calcified coronal pulp chambers (pulp stone). The endodontic treatment of such teeth is one of the toughest procedures in dentistry. Recently, a revolutionary method known as "Guided Endodontics" was introduced to treat teeth with calcified pulp canals and apical disease.[26] The concept behind this innovative approach is to use computed tomographic data to produce a computer-aided guide that will help establish an appropriate access cavity. Surface scan data from an intraoral scanner and volumetric data from CBCT are required for guided endodontics. Both sets of data are overlaid in computer-aided design (CAD) software in order to plan a virtual access cavity and create a template. Next, a 3D printer is utilized to build the template, and drills are used to prepare the cavity. [9]

Electronic Health Records (EHR)

The implementation of Electronic Health Records (EHR) systems in dental practice has improved the management of patient information. EHRs enable the seamless storage, retrieval, and sharing of patient data, enhancing communication between dental professionals and facilitating comprehensive patient care. These systems also support clinical decision-making by providing access to patient history, treatment plans, and diagnostic images. The integration of EHRs in conservative dental practice ensures accurate documentation and continuity of care.[27]

Benefits of Digital Dentistry

The adoption of digital dentistry in conservative dental practice offers numerous benefits, including improved diagnostic accuracy, enhanced treatment outcomes, and increased patient satisfaction. Digital technologies enable precise and minimally invasive treatments, preserving more of the natural tooth structure and promoting better oral health. Additionally, digital workflows streamline dental procedures, reducing chair time and enhancing overall practice efficiency.[2]

Ethical and Legal Aspect of Digital Dentistry

The digitization of patient data in dental practice presents new challenges related to confidentiality and data protection.[11] According to Law No. 11 of 2008 on Electronic Information and Transactions (ITE Law) and Ministry of Health Regulation No. 269/MENKES/PER/III/2008 on Medical Records, patient data stored digitally must be protected from unauthorized access.[28,29] Dental clinics must ensure their systems comply with information security and privacy standards to protect sensitive patient data from potential breaches or misuse.[6]

Informed consent is a critical aspect of using digital technology in dentistry. Based on Law No. 29 of 2004 on

Medical Practice, patients must be adequately informed about the digital technology used in their treatment, including its risks and benefits. This ensures that patients can provide informed consent, which is their fundamental right in receiving healthcare.[30] The quality and safety of digital devices in dentistry are regulated by Ministry of Health Regulation No. 1189/MENKES/PER/IX/2010 on the Safety of Medical Devices and Healthcare Products. Digital tools and devices used in dental practice must meet the quality and safety standards set by the government and regulatory bodies to ensure that the equipment is safe to use and effective in diagnosis and treatment.[31]

Telemedicine services, including teledentistry, are regulated by Ministry of Health Regulation No. 20 of 2019 on the Provision of Telemedicine Services Between Healthcare Facilities.[30] Teledentistry services must be conducted in accordance with existing regulations, ensuring that consultations are carried out by licensed medical professionals and that patient information is protected. This is crucial to ensure that remote services adhere to the same quality and safety standards as in-person services.[32] Informed consent is not just a formality but a communication process aimed at involving patients in decisions about their care. Dentists must provide clear and comprehensive information about procedures, including the technology used, to enable patients to make informed decisions. This is essential for respecting patient autonomy and adhering to good professional practice standards. Both patients and dentists are legally protected by informed consent. Dentists risk being accused of malpractice if they don't have sufficient informed consent. According to the legislation, patients must be informed about the procedure's possible hazards, anticipated benefits, and accessible options, such as choosing not to have it done.[33]

DISCUSSION

Digital dentistry has revolutionized dental practices with its potential to enhance diagnostic accuracy, treatment outcomes, and patient satisfaction. However, this technological advancement also brings forth significant ethical and legal considerations that need to be addressed to ensure the responsible and equitable use of these technologies in dental care. One of the main challenges in ensuring informed consent is explaining complex digital technology to patients.[1] Technologies such as intraoral scanners, CAD/CAM systems, and digital imaging can be difficult for patients without a technical background to understand. A significant ethical dilemma about patients with restricted prognoses may be resolved by the CAD/CAM 3D printed maxillofacial prosthesis, which provides them with a chance for social reintegration that has a positive psychological effect and greatly enhances their well-being. Therefore, dentists should use simple language and provide examples or visual demonstrations whenever possible to help patients comprehend the technology being used.[31]

The use of CBCT scans in patient diagnosis and therapy presents a complicated ethical conundrum. For example, the widely-accepted and highly predictable computerized workflow for guided implant placement offers a less invasive technique while avoiding important structures throughout the surgical operation.[31] Dentists have an obligation to ensure that the technology they use is safe and effective. This involves not only selecting appropriate devices but also having a deep understanding of how they work and their limitations. Continuous training and updating knowledge about technological advancements are essential to ensure that dentists can operate the devices safely and deliver optimal results. The use of digital technology in dentistry often involves handling sensitive patient data. Dentists must ensure that this data is protected in accordance with privacy and information security laws. This includes using secure systems for data storage and transmission and ensuring that only authorized individuals have access to the information.[34]

Dentists are required to instruct patients on how to take care of their teeth and oral health using modern technologies in addition to educating them about treatments and technology. To enhance the longevity and efficacy of digital restorations, for instance, patients should get advice on proper cleanliness and routine maintenance once the restorations are placed. To ensure that the use of digital technology provides maximum benefits, dentists should regularly evaluate and monitor treatment outcomes. This includes collecting patient feedback and conducting clinical audits to identify areas needing improvement. By doing so, dentists can continuously improve the quality and safety of the care they provide.[1] The use of digital technology in dentistry raises significant ethical and legal issues. Informed consent is crucial when introducing new technology to patients, ensuring they understand the benefits and risks. Dentists must also comply with regulations and standards governing the use of digital devices and patient data management. Ethical considerations include maintaining patient confidentiality and ensuring equitable access to advanced dental technology.[35]

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