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RESEARCH ARTICLE

DIGITAL TECHNOLOGIES IN DENTAL PRACTICE: A PARADIGM SHIFT

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Abstract

The advent of digital technologies has instigated a transformative shift in dental practice, markedly enhancing patient experiences and reshaping oral healthcare delivery. This wave of change encompasses Intraoral scanners, paired with CAD/CAM technologies, facilitate the creation of restorations with remarkable exactitude, resulting in superior-fitting prosthetics and improved treatment outcomes. Additionally, the expeditious nature of digital workflows streamlines impression-taking and restoration design, thereby diminishing chairside time and enhancing overall workflow efficiency. Complementing these are sophisticated imaging technologies that afford clinicians detailed 3D visualizations of the oral cavity, which are instrumental in fostering precise diagnoses and scrupulous treatment planning. The influence of digital technology transcends clinical practice, with significant implications for patient engagement and education. Interactive tools and visual aids now enable patients to gain greater insight into their treatment plans and oral health conditions, thus promoting enhanced engagement in their own dental care. Moreover, AR/VR technologies have introduced novel, immersive educational experiences for patients, who can now explore their treatment options in virtual environments and make more informed decisions regarding their oral health. In addition to patient education, the applications of AR/VR in dental practice are multifarious, extending to surgical planning and simulation, pain and anxiety management, remote consultations, prosthodontics, implant planning, dental education, and real-time chairside assistance. These cutting-edge technologies have the potential to refine clinical decision-making and patient outcomes, and to broaden the reach of dental care, especially in underserved areas. Although traditional dental methodologies persist in relevance for certain situations, the integration of digital tools has unequivocally improved aspects such as efficiency, precision, patient communication, and the efficacy of treatments within modern dentistry. Continuing advancements in digital dentistry, with a special focus on AR/VR innovations, are poised to mold the future of oral healthcare, signaling the dawn of a patient-centric, technologically empowered era of dental practice.

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Introduction:-

The landscape of dental practice has experienced a revolutionary change with the emergence of digital technologies, fundamentally altering both clinical protocols and surgical interventions. This exploration delves into the varied applications and consequential effects of digital innovations on contemporary dental healthcare, including individualized treatment plans and cutting-edge surgical methods.

A prominent domain where digital technology has left an indelible mark is in the personalization of patient care. Utilizing digital impressions and Computer-Aided

Design/Computer-Aided Manufacturing (CAD/CAM) systems, dental professionals are capable of crafting custom restorations that harmonize with the distinctive dental anatomy of the patient, achieving a degree of precision and tailoring that was once beyond the reach of conventional manufacturing.
Furthermore, digital protocols have streamlined the process in fixed prosthodontics, elevating both the precision and efficiency of dental restorations. Subsequently, patient satisfaction has seen a notable increase due to these technological advancements, which refine and hasten the treatment experience.
Beyond the clinical scope, digital tools have revolutionized the way patients understand and engage with their oral health care. Digital imagery and simulations offer patients an insightful view into their dental condition, thereby enriching the communication between patient and practitioner. This advancement is essential for promoting well-informed decisions and improving dental health outcomes on a broader scale.

The surgical field of dentistry, too, has embraced the transformative capabilities of augmented reality and virtual reality.
AR2 provides detailed anatomical visual aids for meticulous implant placement and planning, while VR harbors the potential for immersive and advanced training environments, specifically for dental implant procedures. dynamic surgery
overcomes certain drawbacks associated with a static guide such as the
time associated with impressions and lab procedures required for a
static guide and also allows a direct view of the surgical field.
Dynamic surgery allows standard drills to be used for surgery which
comes handy during cases with limited mouth opening

These technologies not only contribute to heightened clinical accuracy but also herald a new era of sophisticated educational approaches, ensuring

dental practitioners are aptly prepared for the demands of a digital landscape.

This document addresses a multitude of applications and contemplates the future trajectory of digital technology within the arenas of clinical and surgical dentistry, underscoring the profound impact on the quality of patient care, the efficacy of treatments, and the evolution of dental education. In navigating this digital transformation, it is also vital to consider the challenges, opportunities, and ethical implications that accompany the technological progression, with the end goal of upholding and advancing the standards of dental care in an increasingly digitized society.

Recent Advances

Technological advancements in virtual and augmented realities has
led to its successful application in dental implantology. In dental
implantology accurate positioning of the implant is essential for
esthetics and functions [02].

Improved Visualization:

Virtual scope: Developed by Areal, Neuilly-sur-Seine, France.

This simulation device allows elimination of position markers during
CT scan as it was thought to create mismatch in the orientation of the
planned position and actual point of entry. This system instead uses an
ultrasound probe for a real time 3D capture. Mapping of the clinical
image is matched to the CT-scanned data and updated continuously
thus creating a registration independent of the guide [03].

Enhanced Understanding: DIVA users reported being better able to identify fractures and lesions that were missed in standard CT-scan renderings. An enhanced understanding of cases of craniofacial trauma is facilitated by this improved abnormality detection.

Enhanced Anatomical Precision: Based on geometric morphometric analyses, landmarking with DIVA produced a 3D representation of landmarks that was comparable to the standard 3D CT-scan visualization, with low mean distortion.

Applications

Augmented reality (AR) improves dental implant planning and placement in a number of ways. For example, it enables the creation of three-dimensional environments or images, which gives clinicians a

detailed visualization of the anatomy of their patients.

The ability to overlay digital data onto an actual image of the patient's teeth and anatomical structures helps In addition to improving communication between the patient, clinician, and other treatment process specialists, this capability also improves the visualization of the final result 2. Better Communication: Augmented reality (AR) systems allow for real-time overlay of digital data, including images, videos, and three-dimensional (3D) models, onto the physical environment, facilitating live communication between nurses and patients. Enhancing patient comprehension and involvement in the treatment process is the interactive feature 2. Improved Operator Cooperation: AR systems have the ability to share resources.

Benefits

Endless scenarios: Unlimited capacity to create a broad range
and deep experience of patient scenarios and treatment required
by creating different disease states. Enables enhanced learning,
and helps evaluate the errors that could possibly occur in real
clinical scenarios better preparing the learning dentists.
• Evaluation: Learning and planning through virtual and augmented reality aids provides overwhelming amounts of data,
tracking the hand movements of the operator enabling submillimeter level accuracy for evaluation. The learning
scenarios could be programmed with a feedback loop to give
students an immediate signal while making a mistake [04].

Challenges:

Learning Curve:

There is a steep learning curve
associated with adopting augmented reality technology in oral implantology. Clinicians and dental professionals may require training and practice to effectively utilize AR systems for treatment planning and implant placements 2.

Clinical Accuracy:

Ensuring the clinical accuracy
and treatment quality of AR-based systems requires further
in vivo clinical trials. It is essential to validate the precision and reliability of AR technology in guiding implant placements to optimize patient outcomes 5.

Geometric Variation:
Addressing geometric variations and errors in AR-based guided surgeries is crucial for enhancing the effectiveness of implant placements. Future studies should focus on minimizing geometric variations through advanced simulations and real-time feedback mechanisms 5.

Expensive infrastructure:
To set up a station that is VR/AR enabled comes at the expense of precious time and money to build and support the ever changing technology.
• Content creation: Building content for a VR/AR platform is a complex process and requires the assistance of an engineer which could again add on to the cost of setting up.

Technical problems
Bugs: not As with any digital platform, AR/VR softwares are immune to bugs which could lead to interruption in the transmission of information [05].

In conclusion, while challenges such as the learning curve and clinical accuracy need to be addressed, the future prospects of using augmented reality in oral implantology are promising. Integration of advanced technologies, robotics, and automation, along with rigorous clinical trials, can lead to enhanced precision, efficiency, and outcomes in dental implant placements
Potential Applications of Augmented and Virtual Reality in

Dentistry:
Augmented and virtual reality (AR/VR) technologies present exciting possibilities for revolutionizing dentistry.Other technologies can be integrated to enhance the current AR systems like Photon emission tomography, near infra-red spectroscopy and the use of dyes, such as indocyanine to identify complex anatomy and vital structures[06].

Surgical Planning and Simulation:
Image Guided Implant ology (IGI): It uses technology similar to its predecessor DentSim which consists of a dental mannequin dental handpiece, lights, infrared cameras and two computers.

This system is based on optical input, the hand piece being equipped with an optical sensor and a camera detector that accurately tracks its

movements. The patient's jaw positions are initially registered using fiducial markers which were incorporated into the acrylic splint. This splint was placed in the patient's mouth during the registry of CT scan and also during the surgery enabling the overlapping of the planned treatment with that of real case scenario [07]. This acts like a feedback preventing the operator from making errors and hence creates minimal to nil deviation from the planned treatment

Patient Education and Treatment Planning:
AR/VR platforms can provide patients with immersive experiences to better understand their dental conditions and treatment options. By visualizing their oral anatomy and proposed treatment outcomes in virtual environments, patients can make more informed decisions and feel more confident about their dental care journey.

Pain Management and Anxiety Reduction:
AR/VR technologies have the potential to mitigate dental anxiety and alleviate pain during procedures. By immersing patients in calming virtual environments or distracting them with engaging experiences, dentists can create more comfortable and relaxing treatment experiences, particularly for anxious or pediatric patients.

Remote Consultations and Teledentistry:
AR/VR platforms can facilitate remote consultations and teledentistry services, allowing patients to receive expert dental advice and treatment recommendations from the comfort of their homes. Dentists can virtually assess patients' oral health, provide real-time guidance, and even conduct virtual examinations, expanding access to dental care, especially in underserved areas

Prosthodontics and Implant Planning:
AR/VR technologies can enhance the design and placement of dental prosthetics and implants. Dentists can use virtual models to precisely plan implant placements, simulate prosthetic restorations, and ensure optimal fit and aesthetics. This can improve treatment outcomes and patient satisfaction in prosthodontic procedures.

Continuing Education and Professional Training:
AR/VR platforms offer immersive and interactive environments for dental professionals to engage in continuing education and training programs. From virtual workshops and simulated surgeries to

interactive case studies, these technologies can enhance skill development, knowledge retention, and proficiency in various dental specialties.

In conclusion, while AR/VR technologies have already made significant contributions to dentistry, there remains vast untapped potential for their application in areas such as surgical planning, patient education, pain management, remote consultations, prosthodontics, and professional training. Continued research and innovation in this field promise to further enhance the delivery of dental care and improve patient outcomes.

Comparison of Traditional Dental Practices and Digital Instruments in Efficiency and Effectiveness:

Traditional Dental Practices:

Manual Processes: Traditional dental practices often involve manual processes for tasks like taking impressions and treatment planning, which can be time consuming and prone to inaccuracies.

Limited Visualization: Without advanced imaging technologies, dentists may have limited visualization of the oral cavity, making it challenging to diagnose certain conditions accurately.

Subjective Treatment Planning: Treatment planning in traditional practices may rely more on the dentist's experience and judgment without the aid of digital tools for precise measurements and analysis.

Patient Communication: Communication with patients using traditional methods such as physical models or 2D images may be less effective in conveying complex treatment plans and conditions.

Digital Instruments:

Enhanced Efficiency: Digital instruments streamline various aspects of dental procedures, such as impression-taking and treatment planning, reducing the time required for these tasks and minimizing errors.

Improved Visualization: Advanced imaging technologies provide dentists with detailed and precise visualization of the oral cavity, enabling accurate diagnosis and treatment planning.

Objective Treatment Planning: Digital tools allow for objective measurement and analysis, facilitating more precise and personalized treatment planning based on patient-specific data.

Enhanced Patient Communication: Digital instruments enable dentists to visually demonstrate treatment plans and conditions to patients using interactive 3D models and simulations, enhancing patient understanding and involvement in their dental care.

Overall, while traditional dental practices have served as the foundation of dentistry for many years, the

integration of digital instruments offers significant advantages in terms of efficiency and effectiveness in contemporary dental practice. Digital technologies enhance visualization, streamline processes, facilitate objective treatment planning, and improve patient communication, ultimately leading to higher-quality patient care.

Results:-

Digital technology has markedly advanced the field of dentistry, providing customized, efficient patient care and enhancing professional education. Digital impressions and CAD/CAM technology have led to highly precise and personalized dental restorations, greatly improving patient outcomes and satisfaction. These tools also deepen patient education and involvement in their own care, enabling more informed decision-making through digital imaging and simulations. Augmented reality and virtual reality are now pivotal in surgical dentistry, improving implant planning and offering comprehensive training environments that contribute to improved clinical skills. The move towards digital education with simulators is accelerating skill development among dental professionals, preparing them for state-of-the-art clinical practice. As dental care continues to innovate, digital technology promises a future of precise, patient focused, and technologically enhanced oral health care.

References:-

1. Artificial Intelligence in Dentistry: Current Concepts and a Peep Into the Future. Alexander B, John S. Int J Adv Res. 2018;30:1105–1108. [Google Scholar]
2. Present and future of artificial intelligence in dentistry. Tandon D, Rajawat J. J Oral Biol Craniofac Res. 2020;10:391–396. [PMC free article] [PubMed] [Google Scholar]
3. Artificial intelligence in endodontics: Current applications and future directions. Aminoshariae A, Kulild J, Nagendrababu V. J Endod. 2021;47:1352–1357. [PubMed] [Google Scholar]
4. Artificial intelligence in dentistry. Deshmukh S. J Int Clin Dent Res Organ. 2018;10:47. [Google Scholar]
5. Application and performance of artificial intelligence technology in oral cancer diagnosis and prediction of prognosis: A systematic review. Khanagar SB, Naik S, Al Kheraif AA, et al. Diagnostics (Basel) 2021;11 [PMC free article] [PubMed] [Google Scholar]
6. Effectiveness of artificial intelligence applications designed for endodontic diagnosis, decision-making, and prediction of prognosis: A systematic review. Boreak N. J Contemp Dent Pract. 2020;30:926–934. [PubMed] [Google Scholar]
7. Use of artificial intelligence in dentistry: Current clinical trends and research advances. Nguyen TT, Larrivée N, Lee A, Bilaniuk O, Durand R. https://pubmed.ncbi.nlm.nih.gov/34343070/ J Can Dent Assoc. 2021;87:0. [PubMed] [Google Scholar]
8. Artificial intelligence in dentistry. Meghil MM, Rajpurohit P, Awad ME, McKee J, Shahoumi LA, Ghaly M. Dent Rev. 2022;2:100009. [Google Scholar]
9. Artificial Intelligence in dentistry: Concepts, applications and research challenges. Babu A, Andrew Onesimu J, Martin Sagayam K. 3:1074. [Google Scholar]
10. Brodie ML. Springer International Publishing; 2019. What Is Data Science? [Google Scholar]
11. Big data and big data analytics: Concepts, types and technologies. Riahi Y, Riahi S. Int J Res Eng. 2018;5:524–528. [Google Scholar]
12. Artificial Intelligence in dentistry: Chances and challenges. Schwendicke F, Samek W, Krois J. J Dent Res. 2020;99:769–774. [PMC free article] [PubMed] [Google Scholar].