REVIEW ARTICLE / REVUE DE LITTÉRATURE

Dental Technology / Technologie Dentaire

RECENT INNOVATIONS AND TECHNOLOGICAL ADVANCEMENTS IN DENTISTRY AND MEDICINE

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Abstract: The newer innovations play an important role in the earlier diagnosis of dental caries based on near-infrared transillumination imaging such as Diagnocam and Soprocare intraoral digital cameras, which aid in the diagnosis of dental caries and also differentiate old and newer dental plaques, respectively. Nanoparticles used as carriers for effective and targeted drug therapies in the treatment of rheumatoid arthritis of the temporomandibular joint (TMJ) and candidiasis among chronic denture wearers provided better-increased bioavailability than oral formulations. Artificial intelligence (AI) uses machines to simulate intelligent human behavior. Augmented reality has been presented as a cognitive extension of AI in health care, emphasizing the auxiliary and supplemental roles of dental and medical practitioners. The article enlightens readers with newer diagnostic methods in dentistry and medicine and innovations such as Surface Topography-Assisted Robotic Superstructures (STARS), Prostate-Specific Membrane Antigen Ligand Positron Emission Tomography/Computed Tomography (PSMA-PETCT), toothbrushes with augmented reality, new hydrogel-based electrodes for Brain-Computer Interface (BCI) applications, and robotics in dentistry.

Keywords : Robotics, Artificial intelligence, Nanoparticles.

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INNOVATIONS ET AVANCÉES TECHNOLOGIQUES RÉCENTES EN DENTISTERIE ET MÉDECINE

Résumé: Les innovations les plus récentes jouent un rôle important dans le diagnostic précoce des caries dentaires basé sur l'imagerie par transillumination à l'infrarouge, telles que les caméras numériques intra-orales Diagnocam et Soprocare, qui facilitent le diagnostic des caries dentaires et différencient également les plaques dentaires anciennes et récentes, respectivement. Les nanoparticules, utilisées comme supports pour des thérapies médicamenteuses efficaces et ciblées dans le traitement de la polyarthrite rhumatoïde de l'articulation temporo-mandibulaire (ATM) et de la candidose chez les porteurs chroniques de prothèses dentaires, ont fourni une biodisponibilité plus élevée que les formulations orales. L'intelligence artificielle (IA) utilise des machines pour simuler un comportement humain intelligent. La « réalité augmentée » a été présentée comme une extension cognitive de l'IA dans les soins de santé, en mettant l'accent sur les rôles auxiliaires et supplémentaires des praticiens dentaires et médicaux. L'article éclaire les lecteurs sur les nouvelles méthodes de diagnostic en dentisterie et en médecine et sur les innovations telles que les superstructures robotiques assistées par topographie de surface (STARS), la tomographie par émission de positrons/tomodensitométrie de ligand d'antigène prostatique spécifique à la membrane (PSMA-PETCT), les brosses à dents à réalité augmentée, les nouvelles électrodes à base d'hydrogel pour les applications d'interface cerveau-ordinateur (BCI) et la robotique en dentisterie.

Mots clés : Robotique, Intelligence Artificielle, Nanoparticules

Introduction

The development of genomic and proteomic multiplex technologies has greatly accelerated the discovery of biomarkers and their use in clinical practice for making diagnostic and treatment decisions [1]. Artificial intelligence (AI) uses machines to simulate intelligent human behavior. In order to understand human-technology interaction in the clinical setting, augmented intelligence has been presented as a cognitive extension of Artificial Intelligence (AI) in health care, emphasizing the auxiliary and supplemental roles of dental and medical practitioners [1]. Robotic automation and assistive technology have many prospects in dentistry for improving the standard of care [1]. Robots might free up human resources for other crucial activities, such as working with patients or other duties requiring advanced cognitive abilities [1]. Dental robots may enhance treatment accuracy and results; however, there are still many different types of hurdles facing the robotic transformation [1]. Robotics-enabled digital dentistry and medicine can help reduce mistakes and improve patient care's overall quality and quantity [1]. For invasive dental operations like tooth preparation and autonomous dental implant implantation, robots and three-dimensional navigation can be used [1]. A robot has haptic interface technologies and advanced simulation for dental procedures and treatment [1].

Methodology: A Prisma strategic search was made using the key words "Recent innovations " Technological advancements" for articles indexed in Pubmed national library of medicine from 2015- 2023 and review done on 28 relevant obtained articles [Fig. 1].

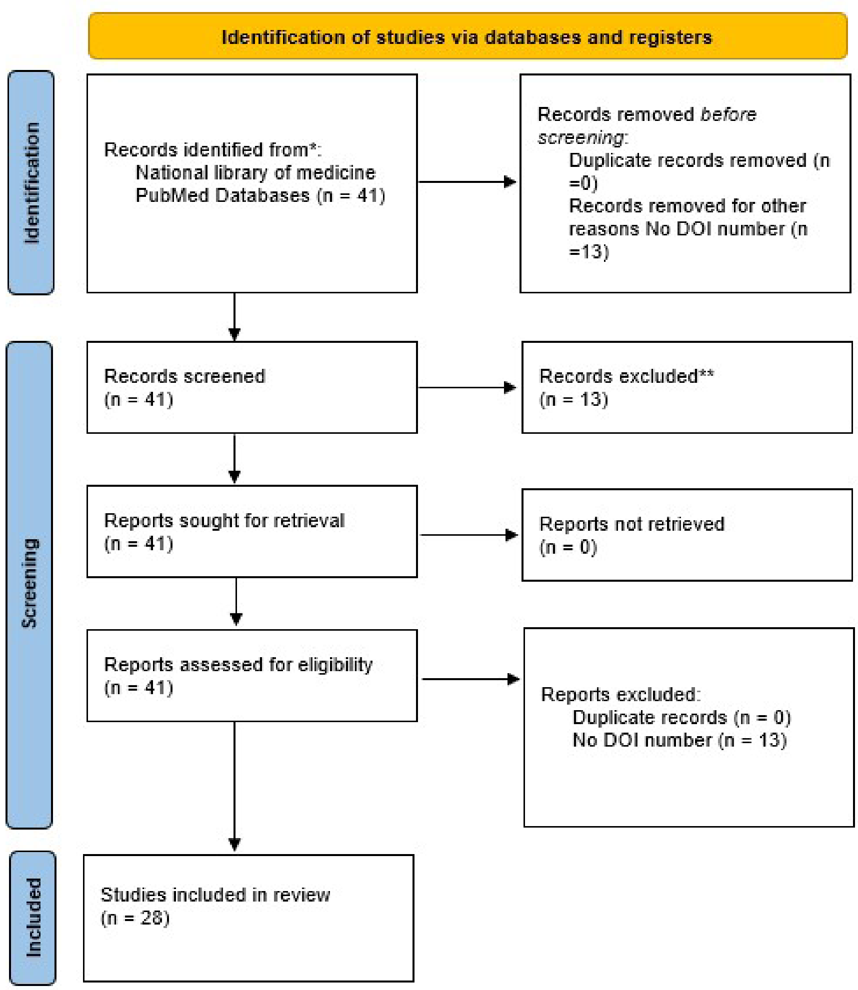

Fig. 1. PRISMA STRATEGIC Flow Diagram.

The recent innovations in dentistry and medicine is enumerated in Table 1.

Recent innovations	Diagnosis
Surface Topography-Adaptive Robotic Superstructures (STARS), Zincoxide nano particles	Biofilm removal
Alpha-Synuclein RealTime- Quaking Induced Conversion (RT-QuIC) Cerebrospinal Fluid (CSF) Assay	Parkinson's disease
Soluble -oligomer Binding Assay (SOBA)	Alzheimer ,Parkinson's disease, Type II Diabetes
Alpha-Synuclein RealTime- Quaking Induced Conversion (RT-QuIC) Cerebrospinal Fluid (CSF) Assay	Parkinson's disease
Positron Emission Tomography (PET) tau imaging	Alzheimer disease
Prostate Specific Membrane Antigen Ligand (PSMA -PET/CT)	Tubarial salivary glands
Vizilite, velscope	Oral cancer
Point of care Diagnostics Mucorales	Mucormycosis
Dental cameras	Diagnocam, Soprocare
Toothbrushes with augmented reality	Plaqless, Magik,Brush Monster
Gentle wave system (GW)	Disinfection of root canals
Cryogen Electron Microscopy cryo-EM	Amyloidosis
Optical Coherence Tomography Angiography (OCTA)	Capillary haemangiomas
Robots in dentistry	Yomi, 6DOFCRS, Motoman UP6

Table 1. Recent innovations and diagnosis.

Review

Surface Topography-Adaptive Robotic Superstructures (STARS):Surface Topography-Adaptive Robotic Superstructures (STARS) is the controlled assembly of reconfigurable, cantilevered bristle-like superstructures made of tightly packed iron oxide nanoparticles using magnetic fields that are modulated in spatial and temporal and topography-adaptive interdental surfaces of the teeth [2]. Surface topography adaptive microstructure robots (STARS) employ a spatially ordered bristle superstructure with tunable stiffness that offers strong cohesion at the base, where support is needed, yet stays reconfigurable at the distal end, where surface conformality is preferred [2]. With the help of this gradient in characteristics, surface topography adaptive microstructure robots (STARS) can self-support, reach, and adjust to changes in surface topography in any orientation while producing enough shear stress to remove biofilms [2]. Additionally, by including scalable and reversible structures, the surface topography adaptive robotic structures (STARS) length may be adjusted to fit into crevices and other complex characteristics, allowing for the precise treatment and removal of different bacteria from the biofilm on difficult-to-reach surfaces [2]. Notably, the catalytic characteristic is maintained throughout reconfiguration, allowing the constructed superstructures to perform mechanochemical functions [2]. Further research into the interactions of reconfigurable soft matter, functional nanomaterials, and microrobotics may be prompted by the discoveries on the interconnectedness of superstructure conformability, topographical adaption, physical force adjustment, and spatiotemporal magnetic field control [2]. Additionally, these dynamic structures can be accurately and automatically moved in both circular and translational motions by the use of automated, programmable control algorithms [2]. In order to merge simultaneous "toothbrushing-like" and "flossing-like" action with real-time antimicrobial activity, sample retrieval for compositional analysis, and pathogen identification, an automated, tetherless multitasking platform is needed [2]. Surface topography adaptive robotic superstructures (STARS) is an operatorindependent procedure that may be helpful, for instance, in the oral health care of people with disabilities who find it challenging to clean their own teeth [2]. Surface topography adaptive robotic superstructures (STARS) aid in an on-demand motion pattern, control, and functional assembly that will result in highly configurable structures able to more effectively remove biofilm on complex three-dimensional tooth surfaces and adjust to various three-dimensional surface geometries and adhesion strengths to achieve autonomous biofilm removal [2].

Soluble Oligomer Binding Assay (SOBA)

The soluble oligomer binding assay (SOBA) detects misfolded amyloid beta proteins that clump together and form small aggregates called oligomers in the blood or cerebrospinal fluid of patients with Alzheimer's disease with mild cognitive impairment, parkinsonism, and Type-2 diabetes mellitus [3]. Strong SOBA signals are produced by pre-incubated synthetic α-sheet-containing Aβoligomers, but not by monomeric and β-sheet protofibrillar Aβ [3].

Alpha-Synuclein RealTime- Quaking Induced Conversion (RT-QuIC) Cerebrospinal Fluid (CSF) Assay

The Alpha-Synuclein RT-QuIC CSF Assay is a new real-time quaking-induced conversion RT-QuIC-based test to identify alpha-Synuclein aggregates in patients with Parkinson's disease and dementia with Lewy bodies' brain and cerebrospinal fluid [4].

Positron Emission Tomography (PET) tau imaging

PET tau imaging appears to be a promising tool for the differential diagnosis of various tauopathies and in the work-up of atypical autosomal dominant (AD) phenotypes that are challenging to diagnose. Currently available tracers consistently bind to paired helical filaments (PHF) of Alzheimer's disease (AD)-type tau, with variable results when it comes to binding in non-Alzheimer's disease (AD) tauopathies such as corticobasal degeneration and progressive supranuclear palsy [4]. 18F [RO-948] retention of second generation tau tracers in the inferior parietal, medial frontal cortex, and temporal (entorhinal cortex, hippocampus, parahippocampus, middle, and inferior gyri) [5].

Prostate Specific Membrane Antigen Ligand (PSMA -PET/CT)

The prostate-specific membrane antigen ligand PET/CT (PSMA-PET/CT) helps in the diagnosis of tubarial salivary glands, a bilateral predominant mucous salivary gland with multiple ducts located near the torus tubarius in the nasopharynx, and sparing this during radiotherapy helps to improve quality of life [6].

Diagnosis of oral cancer

- Velscope

A hand-held device based on autofluorescence is employed as a potential adjunct diagnostic aid for patient populations at high risk for oral cancer [7]. The main advantage is that it is a non-invasive alternative to biopsy [7]. Vibute NA et al. showed a specificity of 44.4 percent when Velscope was used in screening thirty oral cancer patients [7].

Fig. 2. Velscope

- Vizilite

The Food and Drug Administration (FDA) originally recognized the ViziLite® system (Zila Pharmaceuticals, Phoenix, AZ) in 2002 as the first device to enhance the visibility of early cancer lesions during the screening of oral mucosa [8].The kit includes a retractor, a capsule that emits light, and a 1% acetic acid solution; the capsule is made up of a flexible plastic outer shell and a delicate glass vial inside [8]. The inside vial may contain hydrogen peroxide, and the outside capsule may contain acetylsalicylic acid [8]. The chemical products react when the glass vial is broken by the capsule's activation, creating a blueish-white light with a wavelength of 430-580 nm that lasts for roughly ten minutes [8]. The patient uses the acetic acid solution to perform a one-minute rinse to dissolve the glycoprotein barrier and mildly dry the mucosa [8]. A diffuse, blue-white chemiluminescent light is then applied when the ambient light is lowered [8]. The light is reflected by abnormal cells with a higher nucleus-to-cytoplasm ratio and by epithelium with excessive keratinization, hyperparakeratinization, and/or significant inflammatory infiltrate, which appear acetowhite with brighter, more marked, and more distinct borders [8]. Normal cells absorb light and have a bluish colour [8]. Trullenque-Eriksson A etal. stated that the "Vizilite" system has a specificity of 14.2 percent in the 2 of 7 detection of oral cancer [8]. The various clinical studies on Vizilite in oral cancer is enumerated [Table 2].

Author	Year	Clinical results
Do Hyun Kim et al [9]	2022	Chemiluminescence has good sensitivity and comparable to clinical examination in the diagnosis of oral pre-cancer and cancer
Shukla A et al [10]	2018	The sensitivity of Vizilite in the diagnosis of oral potentially malignant disorders is about 90 % and specificity is 50%
Chaudhury A et al [11]	2016	The sensitivity, specificity of chemiluminescence was 84.84%, 41.17% in detection of dysplasia in clinical examination of 100 leukoplakia patients
Sambandham T et al [12]	2013	Vizilite is a useful autofluorescence tool in the early diagnosis of oral cancer and aid in depicting the margins of oral cancer for biopsy site.
Epstein JB et al [13]	2006	Mixed lesions that were both red and white were noticeably enhanced in brightness and sharpness with the ViziLite than only red lesions.

Table 2. Clinical studies on Vizilite in oral cancer

Point-of-Care Diagnostics

- Quantitative Polymerase Chain Reaction (q-PCR) Test kits for Mucormycosis

Mucorgenius@ Realtime Polymerase Chain Reaction test kit manufactured from Pathonostics , MycoGENIE@ from manufacturer Ademtech laboratories, that detects Mucorales and Aspergillus species and aids in diagnosis of Mucormycosis from bronchoalveolar lavage [14]. Fungiplex mucorales (research use only) RUO PCR Kit from Bruker manufacturer detects Mucor spp were commercially available quantitative polymerase chain reaction (q-PCR) test kits for detection of Mucormycosis [14].

Tooth brushes with augmented reality

- Plaqless

Plaqless is a smart toothbrush being marketed in 2020 by Kolibree that detects biofilm using artificial intelligence [15].

- Magik

Magik, the first smart toothbrush with augmented reality, was manufactured in 2018 by Kolibree [15].

- Brush Monster

Brush Monster from Kitten Planet Co. in Yongin, Korea, is a smart toothbrush that offers training based on augmented reality (AR), enabling the user to learn proper tooth brushing techniques and develop healthy tooth brushing habits [16]. Through the use of gaming components integrated into the smartbrush's augmented reality, which can be directly applied to the user's oral cavity, consumers are encouraged to enjoy brushing their tooth brushing habits [16]. Through the use of gaming components integrated into the smartbrush's augmented reality, which can be directly applied to the user's oral cavity [16], consumers are encouraged to enjoy brushing their teeth. Additionally, this brush offers a methodical and visual guide for tooth-brushing posture and direction due to the three-dimensional motion sensor's ability to recognise the user's activity with precision [16]. The brush measured 15 by 14.5 by 176.5 mm and weighed 32 g. It is a sonic electric toothbrush with 1,600 vibrations per minute and an antimicrobial head to prevent irritating the gums [16]. When the user moves the smart toothbrush in their hands, training begins, and consumers are then guided to clean their teeth while viewing themselves in augmented reality on a smartphone application [16]. This smart toothbrush pauses when the tooth-brushing training session ends, and the application's report on brushing behaviour shows the results of the performance [16].

Microbiome Meta-analysis

The microbiome meta-analysis was performed by the SIAMCAT (Statistical Inference of Associations between Microbial Communities and Host Phenotypes) artificial intelligence tool [17]. SIAMCAT is a flexible artificial intelligence tool for comparative metagenome analysis that integrates machine learning, statistical modeling, and cutting-edge visualisation techniques [17]. It also has tools for graphically locating and analyzing confounding variables [17]. SIAMCAT supports computational workflows and large-scale metaanalysis of fifty case-control studies on the connection of microbiome disease with a disease, involving a total of more than ten thousand samples, and explores ways to get over the technological barriers preventing naive cross-study machine learning approaches [17].

HIV Oral Self Assessment Test (HIVOST)

The lateral flow chromatography method used in the HIV oral self-screening test is known as Morcheck, a Morsef Life Sciences, Mumbai product that was made by Bhat Bio-tech India (P) Ltd., Bengaluru, India [18]. An oral brush was included in the kit and was to be used to swab the upper and lower gums and collect saliva [18]. The brush was placed in a test tube filled with a buffer solution and pushed up and down six to eight times [18]. The oral brush was removed after the fluid was squeezed out of it by pressing it up against the test tube's inside wall [18]. The test strip was then placed in the test tube vertically, as seen by the arrow markings pointing downwards [18]. The strip's outcome was deciphered at twenty minutes, but no later than forty-five minutes [18]. While the presence of a control (C) line on the test strip would show that the test was genuine, the presence of a second line known as the test (T) line would indicate Human immunodeficiency virus (HIV) seroreactivity [18]. Regardless of whether a T-line is present or not, a strip would be deemed invalid if the C-line did not appear [18]. HIV oral self-assessment Test Kit is highly sensitive even to HIV IgG and HIV IgM during the first four weeks of HIV infection [18]. Human immunodeficiency virus (HIV) types I and II were distinguished in test results by the establishment of visible bands (three lines) [18].

Nanoparticles for removal of Dental Biofilm

- **ZnO nanoparticles (ZnONP) on oral biofilm**

The floral extract of the anciently used medicinal herb Clitoria ternatea was used in the green manufacture of zinc oxide nanoparticles (ZnO NP), which has shown stability for a longer time [19]. The 10 nm-sized nanoparticles seen in the Transmission Electron Microscope (TEM) image displayed excitation spectra at 360 nm and were discovered to be stable for a long time [19]. By significantly reducing the extracellular polymeric compounds, it was found that the nanoparticles (NPs) were successful in eradicating the oral biofilm created by the two main tooth-attacking bacterial strains, Porphyromonsas gingivalis and Alcaligenes faecalis, via extracellular polysaccharides (EPS) [19]. It was shown that nanoparticle treatment reduced the viability of Porphyromonas gingivalis and Alcaligenes faecalis to 87.89% and 0.25%, respectively, in contrast to amoxicillin [19].

- **Silver nanoparticles from Syzigium cumini leaves**

Lyophilized hydroalcoholic extracts of S. cumini (HEScL) and silver nanoparticles from S. cumini leaves (AgNPs-HEScL) were discovered to have antimicrobial activity against pathogens of interest to dental fields (strict anaerobes: A. naeslundii, F. nucleatum, and V. dispar; facultative anaerobes: S. mutans and S. oralis; aerobes: C. albicans, S. epidermidis, and S. However, at substantially lower concentrations than HEScL, AgNPs-HEScL only exhibited bacteriostatic and fungistatic effects [20]. The development kinetics of single (C. albicans) and mixed (S. mutans/S. oralis and S. aureus/S. epidermidis) biofilms were also potentially partially inhibited by AgNPs-HEScL, depending on the dose and time point [20]. At lower doses or very close to the minimum inhibitory concentration, HEScL and AgNPs-HEScL exhibited in vitro cytotoxicity in NOKSI [20].

Single particle Cryogen Electron Microscope (Cryo-EM)

- **Legobodies**

The technique depends on the presence of a target-binding nanobody, which is then firmly fastened to two scaffolds: a nanobody-binding protein and a Fab fragment of an antibody that is directed against the nanobody, a piece that has been fused to the Fab-binding and maltose-binding protein domains [21]. The whole ensemble, known as the "Legobody," is about 120 kDa, does not affect the interaction between the nanobody and the target, can be quickly identified in electron microscopy (EM) images due to its distinctive shape, and makes particle alignment in cryo-EM (cryogen electron microscope) image processing easier [21]. The 23-kDa membrane protein KDEL (Lys-Asp-Glu-Leu amino acid peptide sequence) receptor and the 22- kDa receptor-binding domain (RBD) of the SARS-CoV-2 spike protein are used to demonstrate the method's usefulness [21]. Both proteins have binding interfaces to nanobodies that can be analyzed using the maps of protein molecular size at even 3.2- and 3.6-kDa resolutions, respectively [21]. Thus, the Legobody method gets beyond cryo-EM analysis's present size restrictions [21].

Cryo-EM helps in the identification of prion proteins such as PrP amyloid (APrP) and the aggregation of prion protein (PrP), which are key steps in the pathophysiology of prion disorders [22]. Plaques composed of PrP amyloid are prevalent throughout the brain in the dominantly inherited prion protein amyloidosis known as Gerstmann-Sträussler-Scheinker (GSS) illness [22].

Gentle Wave System (GW)

The GentleWave system (GW) (Sonendo, Laguna Hills, CA, USA), which was created for cleaning and disinfecting root canals, was released on the US market in 2014 [23]. Without needing to insert the handpiece tip into the canal opening, GW generates a strong, high-speed shear force that dispenses irrigants into the root canal system [23]. In particular, the implosion of microbubbles generates a broadband acoustic field that travels through the fluid to reach the whole root canal system, cleansing the soft tissues and eradicating bacteria within the root canals [23]. Additionally, GW offers negative pressure irrigation, which guarantees reduced irrigant apical extrusion [23]. Distilled water, ethylenediaminetetraacetic acid (EDTA), and sodium hypochlorite (NaOCl) can all be used with the apparatus [23]. At a rate of 45 mL/min, the irrigant is dispensed from the handpiece that is attached to the tooth, and the excess irrigant is simultaneously withdrawn [23].

Soprocare Diagnostic intraoral camera

Soprocare diagnostic intraoral digital camera is manufactured by Acteon [24]. A portable handheld device attached with a camera to detect caries in cario mode [24]. The suspected early carious lesions were alerted by a red colour, the normal healthy dentine appear colourless [24]. It is the only camera that reveals gingival inflammation and distinguishes between old and new dental plaque using auto-fluorescence and selective chromatic amplification (PERIO mode) [24]. The Artificial intelligence-diagnosed dental disorders were tabulated [25] [Table 3].

DIAGNOcam equipment are semantically segmented automatically using deep learning techniques [26].

DIAGNOcam

The DIAGNOcam, manufactured by KaVO Dental in the USA, is based on near-infrared transillumination and is considered an alternative to conventional bitewing radiography to detect cavitation without the risks of ionising radiation in children because it demonstrated higher sensitivity and better accuracy than bitewing radiographs in diagnosing cavitated proximal lesions in primary molars [27].

Nanoparticles for enhanced drug delivery systems

Nanoparticles help in the enhanced drug delivery of methotrexate to prevent articular disc degeneration in temporomandibular joint disorders such as rheumatoid arthritis [28]. Minocycline-incorporated, maleimide terminated polyethylene glycol-polylactic acid (PEG-PLA) nanoparticles in periodontal pockets showed continuous release over a period of fourteen days, with the medicine continuing to be effective against bacteria for more than twelve days and a considerable improvement in periodontal symptoms [28]. Numerous bacteria, including Candida albicans, Candida glabrata, and Candida tropicalis, have had their growth inhibited by the addition of nanoparticles to copper, silver, and palladium [28]. To get around this constraint of poor oral absorption, innovative intravenous (IV) acyclovir has been developed using 200-300 nm polylactic-co-glycolic acid (PLGA) nanoparticles [28]. This kind of nanoparticle-based enhanced drug therapy is more targeted than traditional conventional drug therapy [28].

Diseases diagnosed by Artificial intelligence	Methods of Artificial intelligence
Oral cancer, Cervical lymph node metastases	Convolutional Neural Network (CNN)
Sjogren's syndrome	Pretrained Convolutional Neural Network (CNN)
Oral Lichen Planus	Artificial Neural Network (ANN), Support vector Machines (SVM), Random Forest (RF), Linear Discriminant Analysis (LDA), Naïve Bayes
Aggressive Periodontitis	Multilayered Perceptron (MLP)
Disc displacement and changes	Bayesian Belief Network (BBN)
Dental caries, root fracture, Bone resorption	Pretrained Convolutional Neural Network (CNN)
Osteoarthritis of Condyle	Artificial Neural Network (ANN)

Table 3. Artificial intelligence in diagnosis of dental disorders.

Shape memory elastomers

Shape memory elastomers made of poly Ɛ- caprolactone in the fabrication of surgical stents [29].

conductance-based Organic Electrochemical Neuron (c-OECN)

A mixed ion-electron conducting ladder-type polymer with stable ion-tunable antiambipolarity is used in the construction of a bio-inspired conductance-based organic electrochemical neuron (c-OECN) [30]. The latter simulates the delayed activation of potassium channels and the activation or inactivation of sodium channels in biological neurons [30]. These c-OECNs are capable of stochastic spiking and neurotransmitter- /amino acid-/ion-based spiking modulation, spiking at bioplausible frequencies close to 100 Hz, emulating the majority of essential biological neural characteristics, and stimulating biological nerves in vivo [30].

High intensity Ultrasound (HIU) assisted Quinoa isolated protein nanoparticles for Stabilization of Freeze-dried food Particles

High intensity ultrasound (HIU) assisted modification of enzymatic hydrolysis and cross-linking aids in stabilization of freeze-dried thawed food particles by quinoa isolated protein (QPI) nanoparticles stabilizing Pickering emulsion [31].

Electroencephalogram Silver nanowire Polyvinyl alcohol-based Hydrogel Melamine Sponge (EEGAgPHMS)

A semidry electroencephalogram silver nanowire-based polyvinyl alcohol-based hydrogel melamine sponge (EEG AgPHMS) electrode with controlled-released electrolyte and low impedance [32]. This electrode was employed to create a durable, biocompatible, long-term, noninvasive brain-computer interface (BCI) system [32]. This electrode can keep the impedance of the BCI system between 5 and 15 k for more than 10 hours by utilising its high flexibility and controlled-release electrolyte [32].

Bioactive Biomimetic PLGA/Strontium-Zinc Nano Hydroxyapatite Composite Scaffolds for Bone Regeneration

Bioactive composite scaffolds using PLGA (polylactide glycolide) as the matrix and Sr/Zn-nHAp in various concentrations were used in addition to confirming the incorporation of PLGA in scaffolds, the X-ray diffractometer (Shimadzu Lab X XRD-6100 Diffractometer, Kyoto, Japan) X-ray diffractometer (XRD) pattern and Fourier transform infrared spectroscopy (FTIR) spectra revealed the phase composition and crystal characteristics of nHAp in both Strontium /Zinc-doped powders and composite scaffolds [33]. The release of zinc and strontium ions, which are known to be anabolic to bone, as well as the zinc-containing composite scaffolds, which are known to have antibacterial activity, were both validated by an inductively coupled plasma mass spectrometry (ICP-MS) investigation [33]. In composite scaffolds with less crystalline nanohydroxyapatite (nHAp), a bioactive layer suited for bone regeneration was formed as the Sr/Zn content was increased [33]. Scanning electron microscopy (SEM) and transmission electron microscopy (TEM) studies showed that the scaffolds were capable of forming an orthophosphate layer on the surface when submerged in simulated bodily fluid [33]. Additionally, in vitro investigations on PolyLactide Glycolide (PLGA) degradation showed that Sr/Zn-nHAp-incorporated PLGA degradation increased the pH of simulated body fluid (SBF) and hastened the rate of PLGA weight loss [33]. The strongest material, PLGA-2.5% Zn/Sr nHAp, had an ultimate strength that was most comparable to cancellous bone [33].

Optical Coherence Tomography Angiography (OCTA)

Optical coherence tomography angiography (OCTA) (Topcon DRI OCT Triton, Topcon Corporation, Japan) helps in the assessment of mean tumour vascular density (MTVD) and the presence of vascular loops suggestive of minimal residual disease and thereby aids in post-treatment assessment in patients with vascular tumours like diffuse choroidal hemangioblastomas and retinal capillary haemangiomas [34].

Robotics in Dentistry

Yomi

Neocis, a healthcare startup based in Miami, invented the Yomi robot-assisted surgical tool [35]. The U.S. Food and Drug Administration has approved it as the first (and only) such device for dental implant surgery [35]. By providing physical guidance for the drill's depth, orientation, and location, YOMI was able to prevent the need for a surgical guide that was made specifically for the procedure and operator hand deviation . The navigation system uses vibrational feedback to prepare dental implant osteotomies with excellent predictability and precision [35].

6DOF CRS Robot

A single-manipulator robotic system for tooth arrangement of complete dentures is composed of the following parts: (a) light-sensitive glue; (b) light source device; (c) denture base; (d) control and motion planning; (e) robot modulation software for arranging teeth and a core control system having tooth arrangement; (f) computer; (g) electromagnetic gripper; and (h) 6-DOF CRS robot [35].

MOTOMAN UP6 Robot

Based on the MOTOMAN UP6 robot, the successful tooth-arrangement multi-finger hand (TAMFH) system was developed [35]. Each of the three fingers on the TAMFH has three degrees of freedom [35]. Based on the analysis of motion and workplace simulation, this multi-finger hand satisfies the theoretical requirements of tooth arrangement [35]. However, due to their intricate morphology, the prosthetic teeth were particularly challenging for the multi-finger hand to accurately grab and control [35].

Conclusion

The newer innovations in dentistry and health care aid in early diagnosis and targeted drug delivery more than conventional drug delivery systems. Dental robotics is a revolutionary technology that will alter dental medicine's diagnostic and therapeutic procedures. Robots can complete repetitive tasks for an endless amount of time while improving the overall level and scope of medical care. The most recent medical robots can conduct patient intervention or remote monitoring independently since robotic systems have evolved dramatically over the past ten years. There is, however, a paucity of study information on the therapeutic accuracy and reliability of autonomous robots. Further research studies are needed to enhance its durability and availability. It is essential for health care workers to update on the newer innovative diagnostic tools and innovations in dentistry and medicine to have a piece of sound knowledge in the present digital era.

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