© OCT 2025 | IRE Journals | Volume 9 Issue 4 | ISSN: 2456-8880
DOI: https://doi.org/10.64388/IREV9I4-1711287-7822

Robots Among Us: Understanding the Impact of AI on Robotics Dentistry

DR. ANUSHA VASANTH KUMAR
RajaRajeswari Dental College and Hospital, Bengaluru, India (at time of drafting)
Current Status: Independent researcher.

Abstract- Robots are sophisticated inventions designed to perform tasks that range from simple and repetitive to complex and ingenious servitude. They build a bridge between human competence and automation, enhancing productivity, precision and safety in multiple disciplines. Robotics in dentistry involves the application to handle both routine and intricate tasks that will reform and even transform various aspects of dental treatment. The main intent of this paper is to scrutinize and analyze the practice of AI robotics in dentistry.

I. INTRODUCTION

Robodentistry is like a coin having two faces [1] One face helps patients in an efficient way like a dentist and the other way when turned up can pose unwanted consequences whilst doing the AI assisted operation, since the dentist is still required to monitor the whole process.

John McCarthy originally introduced this field of applied computer science known as artificial intelligence in 1956, it is at time known as Machine Intelligence [2] AI has given life to machines that are equally, perhaps even more capable than a surgeon to operate on a living being [3] Other than this, it is inevitable that long hours of work can be weary to a dentist that may or may not lead to errors in oral examination or diagnosis and even the treatment. AI robots are poised to have a great impact on the field of dentistry by improving diagnostic accuracy, treatment planning and patient care. Robots in concert with 3D navigation can be used for invasive dental procedures like tooth preparation and autonomous dental implant placement [4] They can play a significant role in dental education as well. In this paper, we will look through aspects of AI applications in different departments of dentistry and its effects on health care as well.

Practice & Application of Robodentistry
OPERATIVE DENTISTRY AND ENDODONTICS
Generally dentists diagnose or detect caries in a person, by use of collectible methods to evaluate the health of the teeth which includes Visual examination, Tactile examination, X-rays, Dyes, Laser Fluorescence and Clinical Judgment.

Using AI to detect Dental Caries
Researchers and Tech companies developed AI tools to analyze dental images and detect dental caries [5] Dental caries is a prevalent condition, often requiring time intensive analysis of dental images for diagnosis. AI systems, particularly those using machine learning, can quickly analyze these images and enhance the accuracy of detecting early stages of caries that the human eye may miss.

By analyzing a patient's data and identifying factors, AI systems can predict a patient's likelihood of developing caries in the future, which is more cost effective and beneficial for the patient's oral health [6]

Some of the Categories of AI designed models for Caries Detection

- Convolutional Neural Networks in Image Analysis and Caries Detection
- Support Vector MAchines for Enhanced Dental Caries Diagnosis
- Random Forest Algorithm for Improved Dental Caries Detection

System Segmentation.
The Internal Caries Detection And Assessment System (ICDAS)
The Future of AI based caries detection and diagnosis looks promising. AI can revolutionize dentistry with its potential to enhance accuracy, efficiency and personalized care.

ORAL AND MAXILLOFACIAL SURGERY
Diagnosing of Oral Diseases
Early detection of Oral squamous cell carcinoma (OSCC) is crucial for early management to avoid surgical intervention and attain a better prognosis and overall survival.

© OCT 2025 | IRE Journals | Volume 9 Issue 4 | ISSN: 2456-8880
DOI: https://doi.org/10.64388/IREV9I4-1711287-7822

In a study by Abureville et al. where they used a CNN (Convolutional Neural Networks) algorithm, to diagnose oral squamous cell carcinoma (OSCC) from confocal laser endomicroscopy images (7894) in patients diagnosed with OSCC and the results showed that the CNN algorithm used in the study was good for early diagnosis of SCC. [7]

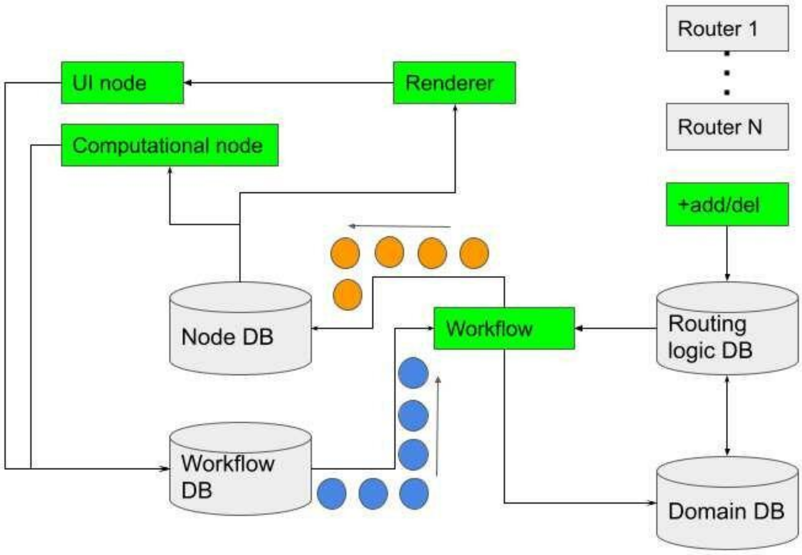
Another similar study by Poedjiastoeti et al. in which they have also used a CNN algorithm to identify and distinguish ameloblastoma and keratocystic odontogenic tumor (KCOT) and the results are positive. [8]

ROBOTICS IN DENTAL IMPLANTOLOGY

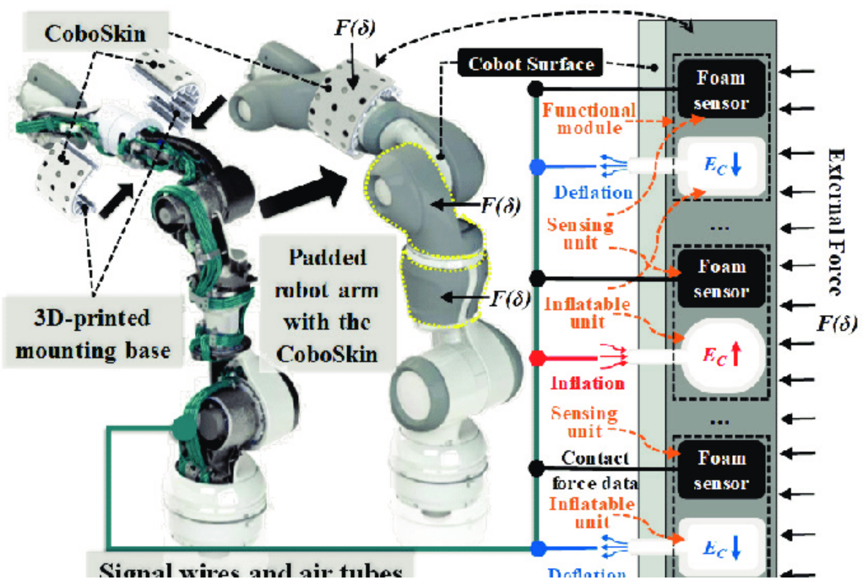
Robot-guided Implantology is spearheaded by Neocis, a company based in the United States of America (Miami, Florida, USA). Founded in 2009, this

The organization has been approved by the Food and Drug Administration (FDA) to use its flagship product "Yomi" with real-world patients in a clinical setting. [9]

The primary input to the robot-guided Yomi comes from a CT scan. The CT information is then fed into dynamic planning software that allows the surgeon plan the surgery accounting for key anatomical features like the nerves, sinus and adjacent teeth [10]

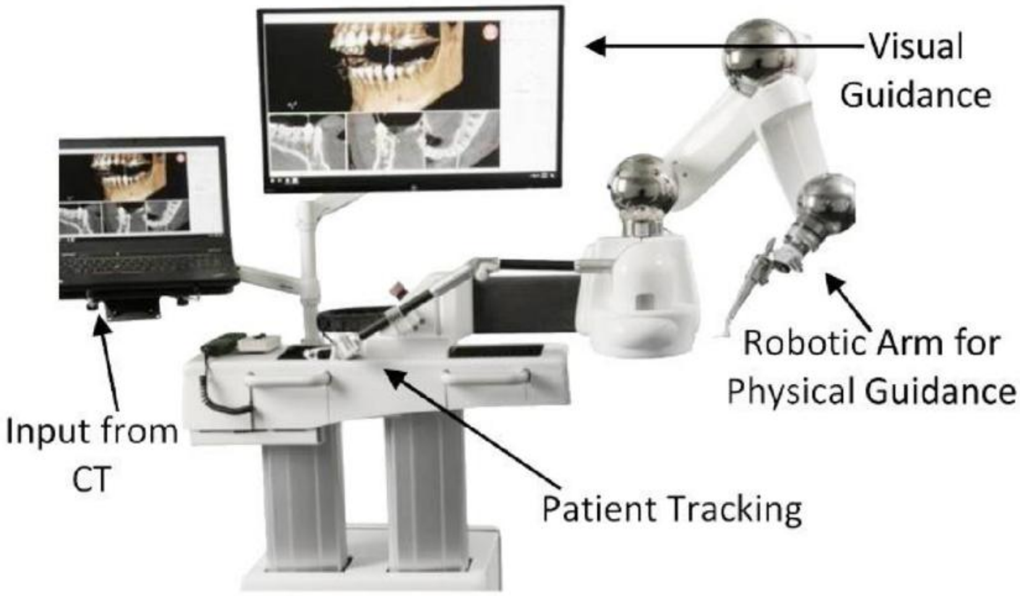


Schematic representation of Yomi's workflow, visual guidance is a real time three-dimensional graphics that provide navigation during surgery and confirms progress.



Physical guidance is provided by the robotic arm which guides the surgeon to position and drill till appropriate depth.

© OCT 2025 | IRE Journals | Volume 9 Issue 4 | ISSN: 2456-8880
DOI: https://doi.org/10.64388/IREV9I4-1711287-7822



Before the procedure begins, a mouthpiece is temporarily attached to your jaw, which is later connected to the robotic guide. A second 3D scan is taken with this splint in place, and preoperative markers are added to allow the technology to track any movement. At this point, you will be appropriately sedated before the surgery begins.

The robot has two arms, a tracking arm that is attached to the mouthpiece and an arm that holds the drill controlled by your surgeon. The tracking arm and markers give the robot the ability to "see" you in real-time, so if there are any subtle movements during the procedure, the robot moves with you to accommodate the surgical plan.

The most impressive part of this robotic technology is that it provides real-time visual, auditory, and physical guidance for unmatched precision. This means that your surgeon can see, hear, and feel exactly where your implant should be placed, the angulation, and the precise depth. The robotic arm will resist any incorrect movements and will sound an auditory beep when the proper position is reached, all while showing the virtual plan on a screen.

Million Dollar question:
Can Robotic-Guided dental implant surgery replace an Oral surgeon?
The YOMI® robotic system does NOT replace your surgeon. Instead, it combines your oral surgeon's skill with the benefits of robotic surgery, further enhancing the surgeon's capabilities. Because nothing operates autonomously, if anything needs to be changed, the surgeon can stop, and provide new instructions to the robots.

This new robotic technology does not allow just any dentist the ability to place implants. The skill and expertise of a prosthodontist or periodontist are necessary to perform a successful robotic-guided dental implant procedure. [11]

Some of the treatment for a patient with a restricted jaw can be done by robotic dental drill where a very fine needle is used to pierce the gum to find a site of the alveolar bone.

PROSTHODONTICS
A prompt and accurate diagnosis is the backbone of treatment and planning. With the increasing use of three-dimensional scanning and imaging, data generation has increased significantly. AI also offers insights into the type of prosthetic rehabilitation required to formalize an individualized treatment plan. AI can aid in designing the prosthesis, determining whether to be a fixed or removable type with selecting components.

Tooth-crown preparation robots
LaserBot, a microrobot is a robotic device that achieves the precise three-dimensional (3D) motion control of a femtosecond laser beam in tooth-crown preparation [12]This miniature robotic device; LaserBot concluded that it achieved precise 3D motion control of a laser focal point and is small enough to be used in the narrow workspace of the oral cavity, and also the limitations of the robot has been identified.

Why is accuracy important when it comes to Tooth Preparation?

At present, dentists perform tooth preparation with a high speed dental handpiece. However, the procedure depends on the skills and accuracy of human vision and movements of the dentists, in the narrow space of the oral cavity. In this, dentists need to be careful and aware to avoid damage to the muscles, soft tissues of the buccal mucosa, lips and tongue along with random jaw motions that can be predicted by the patient during the process. Attaining accurate dimensions of the tooth preparation standards is challenging through manual treatment operations. The complications include, over-or under prepared, excess removal of tooth structure which will lead to hypersensitivity, pupal inflammation and even necrosis. Under preparation can lead to retention trouble, insufficient space leading to tissue damage.

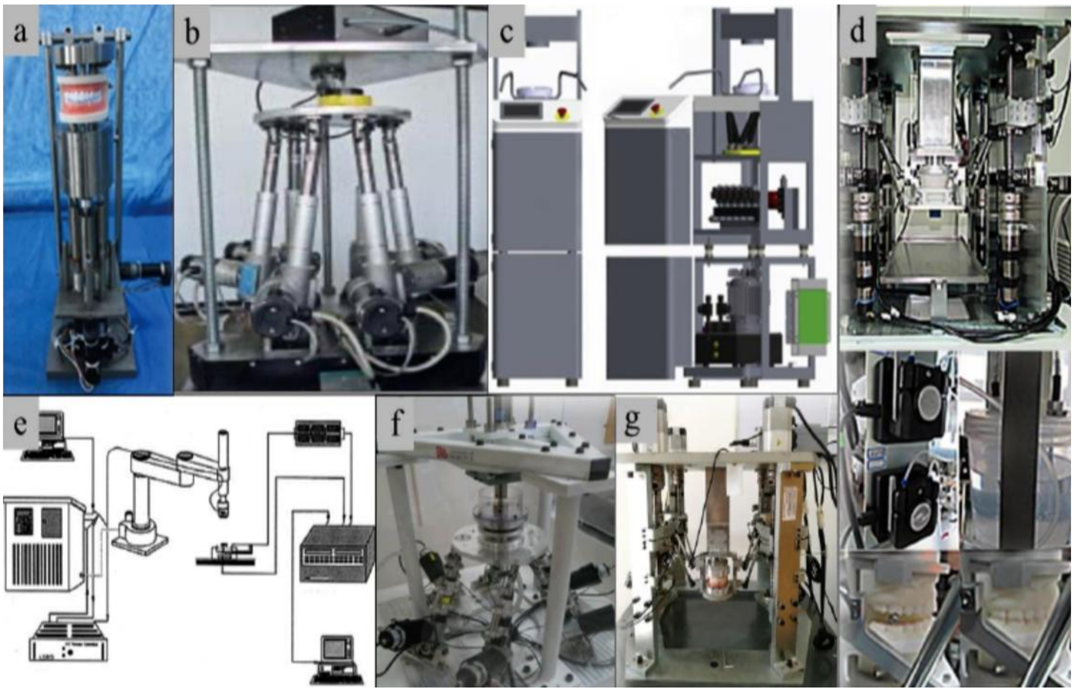
So in recent years, after LaserBot, Ultra Short Pulsed Lasers (USPL) have been introduced to the restorative dentistry.

These laser pulses, which are amplified with energies of up to millijoule [13]

and are focused on the material's surface, allow thin layers to be ablated with a high accuracy and reproducibility, which can result in much less collateral damage to the adjacent tissues compared to using other thermal, chemical, or mechanical processes [14]

Denture testing robots

Different prostheses are fabricated differently, however the traditional technique is to acquire the dental arch curve through manual operation which will inevitably bring numerous errors caused by human factors. The key of a tooth arranging robot is how to handle and position the teeth.



5-DoFIDR(78), b. Conserva et al.(79), c. Tahir et al (81), e. Measurement system of mastication, f. Waseda (87), g. Redundantly actuated parallel manipulator prototype(88)[15]

Zhang et al. [84] proposed a robotic tooth arrangement method using conjugate tooth-caps instead of teeth to be grasped by the robot. [16]The most successful teeth arrangement is made by small multi manipulator type with tooth caps, the teeth arch curve and position is designed using CAD system.

Robotic Articulator.

It uses a precise six-axis micro-positioning stage to reproduce the patient's functional mandibular movement with six Degrees of freedom. Using this type of articulator system, a full veneer crown restoration is made up without the need for intraoral occlusal adjustments. However, further research is needed to evaluate this technique. [17]

PERIODONTOLOGY

Since AI is still in its infancy state, and not yet fully applied in periodontics, its advantages and analysis indicates that there are a lot of benefits to gain by using AI.

Detection of Periodontal diseases

In the year of 2018, Aberin et al. studied differentiation between healthy and periodontitis affected plaque using AI microscopic images of dental plaque. The finding showed 75.5% accuracy. [18] In 2017, Balaei et al. studied pre and post treatment; that is classified as diseased and healthy, the results came up with accuracy of 91.6%. [19]

Using AI for classification of periodontal diseases

In 2017, Rana et al. studied Machine Learning classifier trained annotations from dentists that showed five pixel-wise inflammation segmentations of color augmented intraoral photos, the findings was successful, the classifier differentiates between healthy and inflamed gingiva with precision. The early diagnosis of periodontal diseases using intraoral imaging devices can be advantages for patients and dentists. [20]

In 2015, Ozden et. al. studied classification of periodontal diseases using Artificial neural network, support vector machine and decision tree. DT and SVM showed the best accuracy of 98%, which concluded they are the most useful as a tool for decision making and prediction of periodontal diseases. [21]

Using AI for assessment of periodontal bone level

Assessment of radiographic bone loss can be complex and complicated, and subjective to the examiner. AI algorithms have been designed to automatically identify RBL and the likelihood of tooth loss and periodontal disease. Miller et al. [2023] reviewed the potential of AI models to detect RBL for the diagnosis of periodontal disease. They observed that the mean accuracy in the case of panoramic radiographs ranged between 63% and 94%, while periapical radiographs showed a precision of 25% for detecting mild disease and a high accuracy of 99% for staging of RBL. Specificity for periodontal bone loss ranged between 81% and 83% on cone-beam computed tomography (CBCT), while sensitivity was 45–72% [22]

Artificial Olfaction for detection of Halitosis

An Electric nose is an artificial olfaction, it is an array of non selective sensors used to evaluate the total spectrum of exhaled volatile compounds. AI identifies specific patterns of smell and is used as a reference for future identification. A decision tree-based classifier determines if the subject has oral or extra oral halitosis. Nakhleh et al. [2017] demonstrated an AI-based sensor array consisting of 20 functionalized nanomaterials-based sensors that could successfully differentiate between 17 systemic diseases by analyzing the exhaled breath with 86% accuracy. [23]

Teeth Cleaning Robots.

It represents a novel advancement in dental hygiene technology which is specifically designed to automate and enhance the effectiveness of oral cleaning. AI algorithms and sensitives sensors to efficiently and thoroughly clean all areas of the teeth, including hard to reach spots, enhances overall dental health.

Ishii et al. [21] designed another type of tooth cleaning robot known as an automatic toothbrush. The robot removes the dental plaque which is planted in the mouthpiece, and powered by small motors which moves in an up-down, side- to-side direction along with the teeth. Hoang et al. [91] designed a chemical micro-robot as self-propelled micro-brushes against dental biofilm.

While still in development and not widely available, these robots hold promise for transforming dental care routines by integrating cleaning with oral health monitoring appealing to both individual users and professional dental practices for their potential to streamline dental hygiene and improve oral health outcomes. [24]

ENDODONTICS

Robotics in endodontics offer improved navigation within the root canal, system of teeth, potentially leading to better treatment outcomes and patient satisfaction. The field of advanced robotic systems to enhance root canal treatments is still in the early stages, with ongoing refining research.

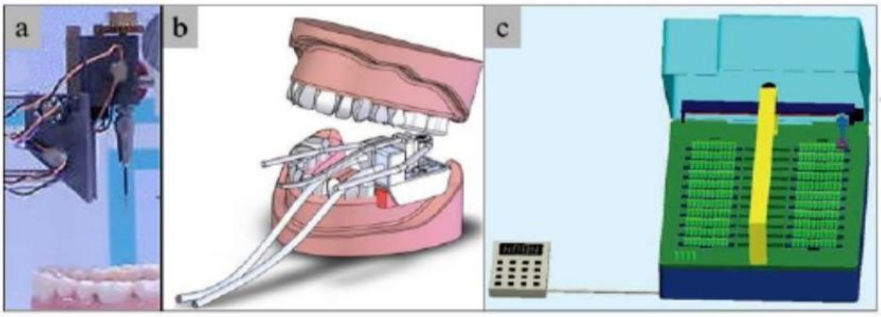


Fig. 10. Endodontic micro-robot: (a) first version micro-robot [99], (b) second version micro-robot [101], (c) model of the canal vending machine [102].

PEDODONTICS AND PREVENTIVE DENTISTRY

In Behavioral Compliance
AI-powered technologies like virtual reality (VR) and augmented reality (AR) alleviate fear and anxiety in pediatric patients, creating immersive and engaging experiences during dental procedures.

Pediatric dentistry stands out as one of the most demanding specialties within the dental field due to cooperation of young patients to the treatment, so the application of vivo exposure therapy (IVET) and virtual reality exposure therapy (VRET). IVET focuses on directly exposing patients to their fears to reduce anxiety levels. Behavior management; AI driven virtual reality tools are being more explored to make dental visits more engaging and less frightening for anxious kids. These types of AI advances can distract and sooth young patients during procedures. Wang, Y. et al. have pioneered the development of a comprehensive toolkit utilizing AI for the assessment of a child's oral health [25]

They analyze patient data, medical records, and other relevant information to make predictions and treatment recommendations. AI has applications in orthodontics for treatment planning, locating multiple cephalometric landmarks, and predicting treatment results

In Endontics
AI can be helpful in evaluating the anatomy of the root canal system, identifying working length measures, diagnosing periapical diseases and root fractures, and forecasting the outcome of retreatment treatments.

For Tooth Anomalies
One of the most widely used deep learning architectures, CNN, is frequently employed for object recognition. Pediatric kids' deciduous teeth are increasingly being evaluated and counted using deep learning techniques like CNN. R-CNN inception has demonstrated good tooth identification accuracy. The first permanent molar ectopic eruption has been accurately identified by AI.

According to Bulatova et al., the AI-based model was more efficient at identifying cephalometric landmarks than manual tracing [26]

In General Dentistry
AI can help with precise shade matching. It has been shown that CNN algorithms are useful tools for automatically identifying cancer and periodontal disease. According to what you and your colleagues found, CNNs were able to identify dental plaque on primary teeth using intraoral photos with clinically meaningful findings. Painless procedure: local anaesthesia can be achieved with AI-supervised nanorobotic anesthesia.

ORTHODONTICS
A comprehensive literature review was conducted, focusing on AI applications in dental diagnostics, cephalometric evaluation, skeletal age determination, temporomandibular joint (TMJ) evaluation, decision making, and patient telemonitoring. The complexity and unpredictability of AI algorithms call for cautious implementation and regular manual validation. The literature on the use of AI in orthodontics can be divided into five main areas: diagnosis and treatment planning, automated landmark detection and cephalometric analysis, assessment of growth and development, treatment outcome evaluation, and miscellaneous applications

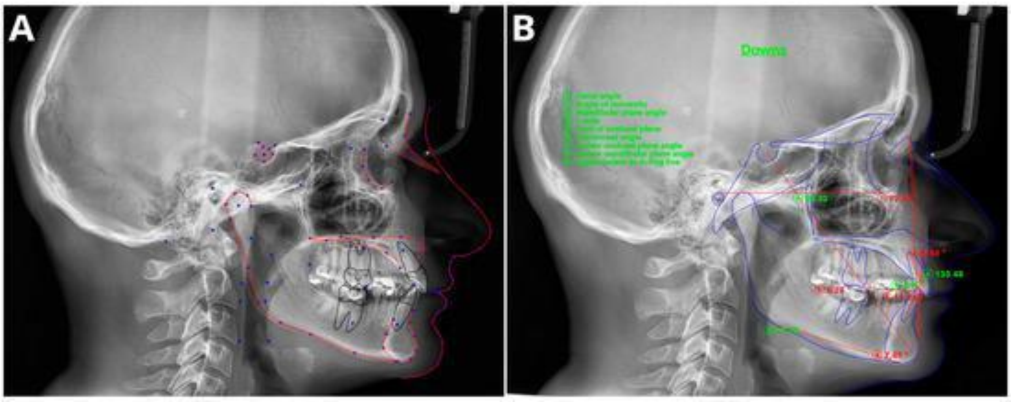
DOI: https://doi.org/10.64388/IREV9I4-1711287-7822

In orthodontics, the adoption of AI has led to the creation of various AI-based programs, such as WeDoCeph (Audax, Ljubljana, Slovenia), WebCeph (Assemble Circle, Seoul, Republic of Korea), and CephX (ORCA Dental AI, Las Vegas, NV, USA). These systems can automatically identify cephalometric landmarks, compute angles and distances, and generate cephalometric reports with significant findings. AI programs are now easily accessible on mobile devices, making AI tools widely available and promoting equal access for all interested users.

Cephalometrics

Cephalometric analysis (CA) is an important diagnostic tool in orthodontics that has been in use since 1931 [27]

Automated CA has been shown to be more stable and repeatable than manual analyses, which rely heavily on operator-dependent landmark identification and often exhibit significant variability. A recent study by Hwang et al. (2020) concluded that automated cephalometric landmark identification can be as reliable as an experienced human reader [] AI methods demonstrated greater accuracy in landmark identification and reduced the time and human labor required. In other studies conducted by Hwang et al. and Yu et al, the authors found no statistically significant differences between the results of automated cephalometric analysis and those calculated via manually identified landmarks.



However, recent advancements in AI have revived interest in CBCT-based CA. Several studies] have shown that AI techniques are accurate and efficient for automatically identifying and analyzing landmarks, surpassing manual approaches. Overall, AI tools have shown promising results in automated cephalometric analyses, but caution is advised due to potential biases in evaluated studies

Determination of Skeletal Age

Growth and maturation play crucial roles in orthodontics because they directly impact the effectiveness of orthodontic treatments, which are often timed to coincide with periods of rapid growth and developmental changes in facial structure.

Seo et al. (2021) reported that CNN-based models achieved more than 90% accuracy in CVM assessments, suggesting that automatic diagnosis using lateral cephalometric radiographs can accurately determine skeletal maturity [28]

Caution is advised when interpreting AI-assisted CVM assessment studies due to the limited number of expert readers used to establish the gold standard for evaluation.A recent systematic review by The Angle Orthodontist reported that the model accuracy for test data ranged from 50% to more than 90%. The authors emphasized the importance of conducting new studies to develop robust models and reference standards that can be applied to external datasets.

TMJ Evaluation

Osteoarthritis (OA) is a condition that affects joints and is characterized by the gradual deterioration of joint cartilage, bone remodeling, and the formation of osteoproliferative bodies

Temporomandibular joint osteoarthritis (TMJOA) is a specific type of temporomandibular disorder that can cause significant joint pain, dysfunction, and dental malocclusion and a decrease in overall quality of life

The 2023 study by Almasan [29] showed that the pooled sensitivity and specificity of AI in panoramic

© OCT 2025 | IRE Journals | Volume 9 Issue 4 | ISSN: 2456-8880
DOI: https://doi.org/10.64388/IREV9I4-1711287-7822

radiograph TMJOA detection accounted for 0.76 (95% CI 0.35–0.95) and 0.79 (95% CI 0.75–0.83), respectively. Similar results related to this topic were reported by Xu [], who reported a pooled sensitivity, specificity, and area under the curve (AUC) of 80%, 90%, and 92%, respectively. A more comprehensive study carried out by Jha et al. [30]

The results of the meta-analysis showed the high diagnostic accuracy of the tested AI models, with accuracy and specificity ranging from 84% to 99.9% and 73% to 100%, respectively.

Orthognathic Surgery Decision Making and Planning
Despite significant developments in orthodontics and surgery, there is a lack of clearly established criteria for qualifying patients for surgical procedures. This issue becomes particularly problematic in borderline cases, where the orthodontist faces the decision of whether to refer the patient for surgical treatment or camouflage treatment. There is a limited yet promising body of literature that assesses the performance of AI in orthognathic surgery treatment planning. Knoops et al. conducted a study in which they applied a 3D morphable model (3DMM) to automatically diagnose patients, categorize their risk levels, and generate simulations for orthognathic surgery treatment plans. This approach achieved a sensitivity of 95.5% and a specificity of 95.2%, with an average accuracy of 1.1 ± 0.3 mm.

It is worth noting that the abovementioned research shares the same limitations as those discussed in the extraction decision-making chapter, primarily due to the absence of clear guidelines.

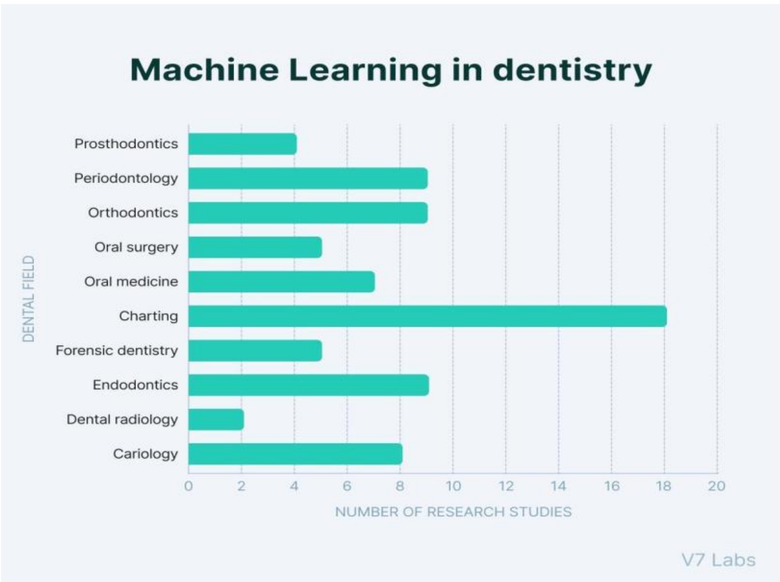
Treatment Outcome Prediction
Orthodontists face the challenge of selecting the most appropriate treatment strategy for each patient based on their individual expectations, socioeconomic conditions, cultural background, and skills. However, procedures such as extractions and orthognathic surgeries are irreversible and can result in permanent patient dissatisfaction. Therefore, accurately predicting treatment outcomes is crucial for both practitioners and patients. Fortunately, a growing body of literature demonstrates the effectiveness of AI in predicting orthodontic and orthognathic treatment outcomes

ORAL MEDICINE AND RADIOLOGY
Radiography, intraoral scans, and facial scans often present dental practitioners with a quantity of overwhelming and unstructured data. The good news? AI-driven dental imaging software can help make sense of the data quickly and efficiently.

ML is already being used for:

- Automated interpretation of dental images (radiographs, CBCT, and MRI scans)
- Treatment recommendations
- Future dental disease predictions
- And more. The best part? Algorithms also proved to outperform dentists in diagnosing tooth decay or predicting whether a tooth should be extracted, retained, or have restorative treatment.

Take a look at the breadth of ML research across a variety of dental fields:

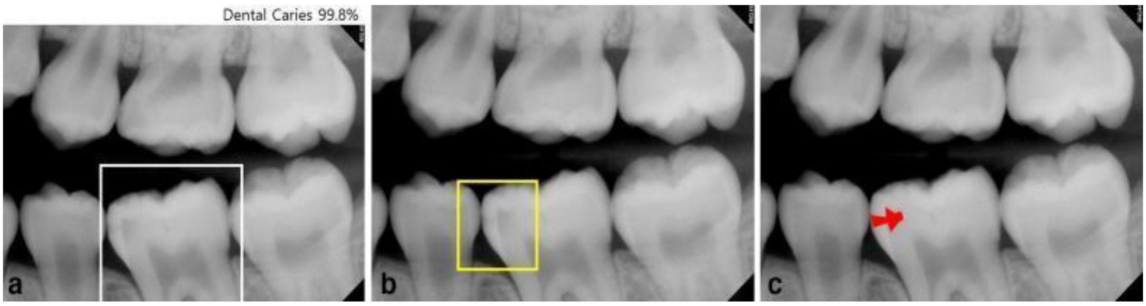


© OCT 2025 | IRE Journals | Volume 9 Issue 4 | ISSN: 2456-8880
DOI: https://doi.org/10.64388/IREV9I4-1711287-7822

AI is rapidly transforming oral medicine and radiology by offering tools for automated image analysis, improved diagnostic accuracy, and more personalized treatment planning, assisting in the detection of caries, oral cancer, periodontal disease, and conditions like osteoporosis from dental images such as radiographs and cone-beam CT (CBCT) scans.

CNNs in the radiology field can be used for classification, detection and segmentation. Classification is the task ranging widely from determining the presence or absence of a disease to identifying the type of malignancy. With advances in computing power, deeper and more complex CNN models have been introduced to solve classification problems in radiographic image analysis. Detection is performed to identify and localize regions with lesions or certain anatomical structures in radiographic image analysis.

CNNs for detection tasks are fundamentally similar to those used for classification tasks. However, several layers with additional functions, such as a region proposal or regression, have been added to CNNs for disease detection.



a. Dental caries are present in the rectangular box on the image (classification). b. Dental caries are detected in the square box (detection). c. A dental caries is segmented on the image (segmentation).

Applications of AI in oral radiology
Automated Image Analysis: AI algorithms can automatically detect and classify dental anomalies like caries, root fractures, and periodontal disease on various radiographic images.
Early Detection: AI aids in the early detection of potentially malignant and malignant oral lesions by analyzing tissue changes from imaging and other data.

Cephalometric Analysis: AI-powered software can automatically mark and trace cephalometric landmarks, making the process faster and more efficient.

AI can identify indicators of osteoporosis on panoramic radiographs, assisting in early diagnosis and referral.

© OCT 2025 | IRE Journals | Volume 9 Issue 4 | ISSN: 2456-8880
DOI: https://doi.org/10.64388/IREV9I4-1711287-7822

Oral Cancer Screening: AI can screen and classify altered oral mucosa, helping to identify premalignant and malignant changes.

AI in Oral Medicine
AI analyzes patient data, including medical history and clinical indexes, to support dentists in making informed and personalized treatment decisions.

Treatment Planning: By considering unique patient characteristics, AI algorithms can recommend the most effective and targeted treatment options.

Prognosis and Therapeutic Response: AI can help predict disease prognosis and a patient's response to therapy, leading to improved patient care.

Patient Support: AI-powered virtual assistants can provide real-time support and information to patients, enhancing access to care

PUBLIC HEALTH DENTISTRY
Compared to humans, AI-based virtual dental assistants can perform several tasks with greater precision, fewer errors, and less manpower. Some of these tasks include:

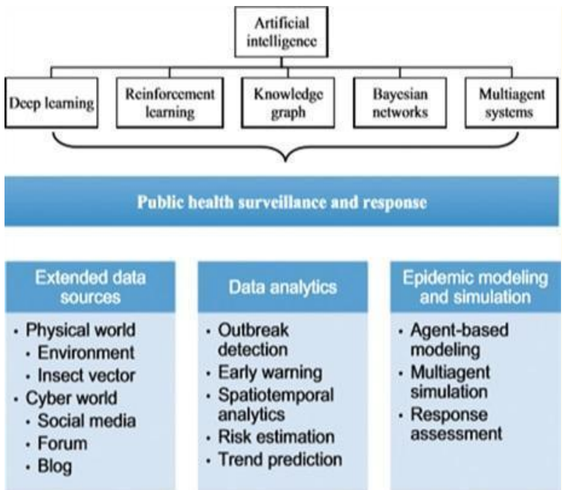
Health protection: Analysing patterns of data for almost real-time surveillance and disease detection. Providing emergency tele – assistance in cases of dental emergencies when the dental health-care expert cannot be contacted. Ex: Early suspected premalignant and malignant alterations in the mucosa[1,13]

Health promotion: AI offers targeted and personalized health advice based on risk profile and behavioral patterns. Ex: Alerting the dental health-care provider about any relevant medical history that might accurately predict a genetic predisposition for oral diseases for a large population[1]

Health education: There has been a recent inclusion of AI in intelligent tutoring systems such as the Unified Medical Language System, which has a significant improvement in the quality of feedback provided to students by the preclinical virtual patient. The interactive interphase allows students to evaluate and compare their work to the ideal, resulting in high-quality training environments. This system is evident in achieving a competency-based skill level faster, than with traditional simulator units[14]

Remote patient monitoring: To monitor patients in rural areas remotely using telehealth technology, monitoring chronically ill people, and the elderly at home using wearable devices or sensors, but the nonintrusive aspects are also attractive for use in hospitals for postsurgery patients, and those in intensive care units using wireless body sensors. These types of applications can present data related to diagnosing and predicting patient health status and assist with clinical decision-making

AI-based epidemiological surveillance is a promising approach in detecting, monitoring, and predicting the spread of diseases that employs AI technologies to analyze the data from multiple sources, such as electronic health records, social media, and news articles.The main objective of public health surveillance and response is to analyze and predict disease trends through modeling the disease transmission dynamics and assess public health responses. With the help of these numerous organizations at the national and international levels, including hospitals, pharmacies, public, state, and political health organizations, one can achieve a timely, focused, and effective response to emerging health events through early, automatic notification of things like bioterrorist attacks, radiation exposure, contaminated food or water supplies, and other population-related health patterns (such as periodontal disease, oral cancer, or malnutrition).



Enabling and enhancing public health surveillance and response approaches through artificial intelligence applications

II. CONCLUSION

AI is redefining dentistry by enhancing diagnostic accuracy, treatment planning, and patient care. AI-driven models, including machine learning, deep learning, and neural networks, have demonstrated high precision in radiographic analysis, disease detection, prosthodontic design, and orthodontic treatment planning. Indeed AI applications extend beyond clinical practice to foci such as forensic odontology and dental education, improving diagnostic efficacy and treatment planning. In addition, application of AI driven models in dental education should vastly improve the quality of both undergraduate and postgraduate education in future. While AI continues to evolve, its successful integration into dentistry requires robust validation, interdisciplinary collaboration, and regulatory frameworks to ensure clinical reliability. Future advancements in AI will further refine treatment modalities, optimize workflows, and contribute to evidence-based, data-driven dentistry, ultimately improving patient outcomes and reshaping the future of dental care.

New technologies are developed and adopted rapidly in the dental field. AI is among the most promising ones, with features such as high accuracy and efficiency if unbiased training data is used and an algorithm is properly trained. Dental practitioners can identify AI as a supplemental tool to reduce their workload and improve precision and accuracy in diagnosis, decision-making, treatment planning, prediction of treatment outcomes, and disease prognosis. Dental practitioners can identify AI as a supplemental tool to reduce their workload and improve precision and accuracy in diagnosis, decision-making, treatment planning, prediction of treatment outcomes, and disease prognosis — ultimately shaping a new era of precision dentistry.

Declaration of Interest

The author declares no conflict of interest related to this study

Author Contribution

The author was solely responsible for the conception, drafting, and final approval of this manuscript.

Ethical Approval

No ethical approval was required for this study as it is a narrative literature review

Funding

This research received no external funding.

REFERENCES

[1]. Ahmad, P., et al. (2021). Dental Robotics: A Disruptive Technology. Sensors, 21(10), 3308. https://doi.org/10.3390/s21103308
[2]. Ding, H., et al. (2023). Artificial intelligence in dentistry—A review. Frontiers in Dental Medicine.
[3]. Fatima, A., et al. (2022). "Advancements in dentistry with artificial intelligence" — published in Healthcare PMC.
[4]. Jedamzik, S. (2019). Digital health and nursing: The future is now. Unfallchirurg, 122(9), 670–675. https://doi.org/10.1007/s00113-019-00705-6
[5]. Gao, S., Wang, X., et al. (2025). artificial intelligence in dentistry: A Narrative Review of Diagnostic and Therapeutic Applications. Medical Science Monitor, 31, e946676. https://doi.org/10.12659/MSM.946676
[6]. Kaur, K. (2024). Artificial intelligence in robo dentistry: A double-edged sword. Journal of Oral Medicine, Oral Surgery, Oral Pathology and Oral Radiology, 10(2), 88–92. https://www.ipinnovative.com/open-access-journals
[7]. Rahim, A., et al. (2024). "Artificial intelligence-powered dentistry: Probing the potential, challenges, and ethicality of artificial intelligence in dentistry" — published in Digital Health (Vol. 10, Issue 5) PMC.
[8]. Miloglu, O., Güller, M. T., & Turanlı Tosun, Z. (2022). The Use of Artificial Intelligence in Dentistry Practices. Eurasian Journal of Medicine, 54 (Suppl. 1), S34-S42. https://doi.org/10.5152/eurasianjmed.2022.22301
[9]. Ossowska, A., et al. (2022). artificial intelligence in dentistry — Narrative Review. International Journal of Environmental Research and Public Health, 19(6), 3449. https://doi.org/10.3390/ijerph19063449
[10]. Shi, J. Y., et al. (2024). Improved positional accuracy of dental implant placement: robot-assisted vs freehand. Journal of Clinical Periodontology. https://doi.org/10.1111/jcpe.13893
[11]. Jang, T. J., Kim, K. C., Cho, H. C., & Seo, J. K. (2021). A fully automated method for 3D individual tooth identification and segmentation in dental CBCT. arXiv. https://arxiv.org/abs/2102.06060

[12]. Cheng, H.-F., Ho, Y.-C., & Chen, C.-W. (2023). DentiBot: System design and 6-DoF hybrid position/force control for robot-assisted endodontic treatment. arXiv. https://arxiv.org/abs/2310.09691

[13]. Hwang, J.-J., Azernikov, S., Efros, A. A., & Yu, S. X. (2018). Learning beyond human expertise with generative models for dental restorations. arXiv. https://arxiv.org/abs/1804.00064

[14]. Pagliara, L., Ferrentino, E., Chiacchio, A., & Russo, G. (2025). Haptic bilateral teleoperation system for free-hand dental procedures. arXiv. https://arxiv.org/abs/2503.21288

[15]. Aubreville, M., Knipfer, C., Oetter, N., Jaremenko, C., Rodner, E., Denzler, J., Bohr, C., Neumann, H., & Stelzle, F. (2017). Automatic classification of cancerous tissue in confocal laser endomicroscopy images using deep learning. Scientific Reports, 7, 11979. https://doi.org/10.1038/s41598-017-12331-8

[16]. Hwang, H.-W., Park, J.-H., Moon, J.-H., Yu, Y., Kim, H., & Donatelli, R. E. (2019). Automated identification of cephalometric landmarks: Part 2—Might it be better than human? Korean Journal of Orthodontics, 49(5), 338–351. https://doi.org/10.4041/kjod.2019.49.5.338

[17]. Hwang, H.-W., Moon, J.-H., & Donatelli, R. E. (2021). Evaluation of automated cephalometric analysis based on the latest deep learning method of automatically identifying cephalometric landmarks. Korean Journal of Orthodontics, 51(4), 244–252. https://doi.org/10.4041/kjod.2021.51.4.244

[18]. Kazimierczak, W., et al. (2024). Accuracy of artificial intelligence for cervical vertebral maturation assessment: A systematic review. Journal of Clinical Medicine, 13(14), 4047. https://doi.org/10.3390/jcm13144047

[19]. Knoops, P. G. M., Al-Omari, I., Velthuis, S., … & Dunaway, D. (2019). A machine learning framework for automated diagnosis and computer-assisted planning in plastic and reconstructive surgery. Scientific Reports, 9, 13597. https://doi.org/10.1038/s41598-019-49811-1

[20]. Lee, H., Choi, Y.-J., Jang, J., & Kim, H. (2023). Automatic identification of posteroanterior cephalometric landmarks using deep learning. Scientific Reports, 13, 16522. https://doi.org/10.1038/s41598-023-42870-z

[21]. Miller, A., & Lam, M. (2023). Artificial intelligence applications for the radiographic detection of periodontal disease: A scoping review. Journal of Evidence-Based Dental Practice, 23(2), 101825. https://doi.org/10.1080/19424396.2023.2206301

[22]. Oetter, N., Knipfer, C., Rohde, M., et al. (2016). Development and validation of a classification and scoring system for the diagnosis of oral squamous cell carcinomas through confocal laser endomicroscopy. Journal of Translational Medicine, 14, 159. https://doi.org/10.1186/s12967-016-0919-4

[23]. Özden, F. Ö., & Özgönenel, O. (2015). Diagnosis of periodontal diseases using different classification algorithms: A preliminary study. Nigerian Journal of Clinical Practice, 18(3), 416–421. https://doi.org/10.4103/1119-3077.151788

[24]. Poedjiastoeti, W., & Suebnukarn, S. (2018). Application of convolutional neural network in the diagnosis of jaw tumors. Healthcare Informatics Research, 24(3), 236–241. https://doi.org/10.4258/hir.2018.24.3.236

[25]. Rana, A., Yauney, G., Wong, L. C., Javia, P., Muftu, A., & Shah, P. (2017). Automated segmentation of gingival diseases from oral images. Proceedings of the Machine Learning for Healthcare Conference (MLHC). [Preprint]. https://www.pratiks.info/uploads/automated-segmentation-of-gingival-diseases-from-oral-images.pdf

[26]. Tariq, A., Hussain, M., & AlJehani, Y. (2023). Efficiency and accuracy of artificial intelligence in the detection of periodontal bone loss: A systematic review. Cureus, 15(7), e41645. https://doi.org/10.7759/cureus.41645

[27]. Xu, L., Chen, J., Zhang, B., Wang, Y., & Jiang, C. (2023). Artificial intelligence for detecting temporomandibular joint osteoarthritis using radiographic image data: A systematic review and meta-analysis of diagnostic test accuracy. PLOS ONE, 18(7), e0288631. https://doi.org/10.1371/journal.pone.0288631

[28]. Almășan, O., Vlasa, A., Petrescu, N., … & Almășan, M. (2023). Temporomandibular joint osteoarthritis diagnosis employing artificial intelligence: Systematic review and meta-analysis. Journal of Clinical Medicine, 12(3), 942. https://doi.org/10.3390/jcm12030942

[29]. Nakhleh, M. K., Amal, H., Jeries, R., … & Haick, H. (2017). Diagnosis and classification of 17 diseases from 1,404 subjects via pattern analysis of exhaled molecules. ACS Nano, 11(1), 112–125. https://doi.org/10.1021/acsnano.6b04930

[30]. Yu, D., Liu, Z., Chen, J., … & Li, L. (2022). Deep learning-based diagnosis for cysts and tumors of the jaw on panoramic radiographs. Scientific Reports, 12, 1643. https://doi.org/10.1038/s41598-022-05913-5