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THE POWER OF AI TECHNOLOGY IN DENTISTRY

Figure 1. Photo courtesy of Orca-AI.

Artificial intelligence (AI) techniques are being incorporated into the dental field to aid dental providers with diagnostic accuracy, treatment planning, and to provide clinical decision support. Machine learning, deep learning, cognitive computing, and natural language processing are subfields of AI that have found their way into dentistry.[1] These techniques work by utilizing data to learn complex processes and simulate human activity, such as analyzing visual images and performing image diagnostics.[2] These AI processes and associated techniques can detect pathology in dental disease and oral cancer. In addition, AI can provide clinical decision support by identifying anatomical structures and detecting anomalies to provide comprehensive patient care.

Natural Language Processing To Enhance Workflow

An AI technique being used in dentistry is natural language processing (NLP). This type of linguistics applies algorithms to identify the human language in ways that a computer can comprehend. NLP works to assist dental providers by voice prompts. To illustrate, DexVoice uses natural language processing through an Amazon Alexa-enabled platform and allows the clinician to use their voice to capture, show, and compare radiographic images; all of which can be accomplished hands-free.[8] Currently, DexVoice is an add-on to DEXIS software and is essentially designed to optimize workflows by using only voice cues; therefore, devoting more time to patient treatment and consultation.

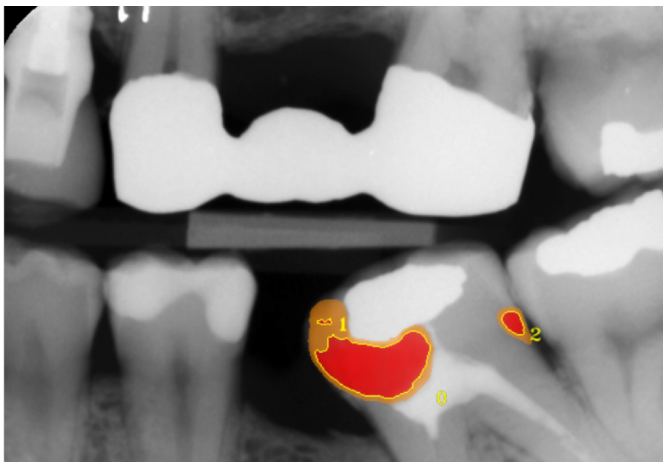


Figure 2. Orca-AI highlighting caries. Photo courtesy of Orca-AI.

Diagnostic Capabilities of AI

While AI is being used to improve workflow processes, deep learning capabilities of AI are also being used to increase diagnostic accuracy as well. AI technology uses algorithms to analyze dental radiographs through image detection, classification, and segmentation. For example, dental decay can be detected based on learning the location and morphology of carious lesions on radiographs, and findings can be identified and annotated immediately with accuracy. ORCA Dental AI offers an innovative caries detection solution that can read multiple image sources, including bitewings, panoramic films, and periapical scans to provide a comprehensive insight of a patient's dental condition.[3]

Similarly, AI is being used to analyze images of oral cancer lesions for early detection and diagnosis. Mobile Mouth Screening Anywhere (MeMoSA) is a mobile application that enables early detection of oral cancer for remote diagnosing.[13] In future developments, MeMoSA will integrate deep learning within the app, where the system will be able to differentiate and classify images of lesions into categories.[9] With specific input variables and risk factors, predictions can be mapped, and lesions can be classified accordingly.[10]

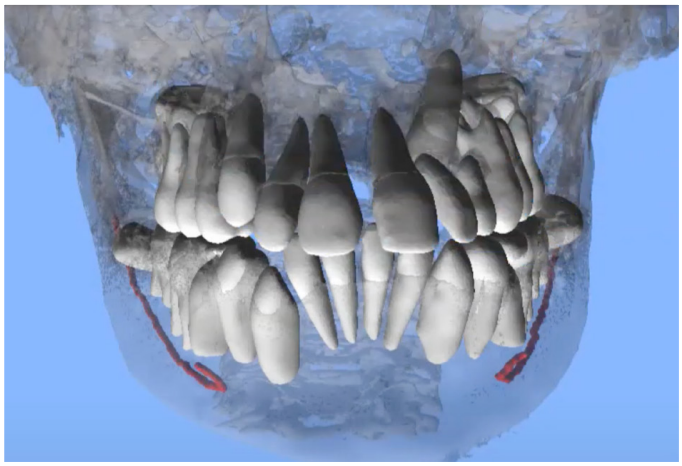


Figure 3. CephX CBCT segmentation. Photo courtesy of Orca-AI.

AI Analysis, Segmentation, And Automation

AI and related processes in diagnoses regarding oral diseases show a profound impact in increasing the quality of dental care, including its use in other fields of dentistry. Orthodontics is utilizing AI technology for diagnosing and treating malocclusion. For example, CephX is a cloud-based system that provides professional cephalometric analysis within seconds. In addition, CephX provides automated teeth segmentation to validate patient anatomy in 3D from CBCT scans, as well as automated and instant airway volume analysis from 3D volume CBCT data.[4] In prosthodontics, Orca's nerve canal algorithm can read CBCT images and instantaneously detect and segment the mandibular nerve canal and provide coordinates of the mandibular and maxillary arches, enabling an accurate outline of the arch anatomy.[4] Complicated problems of uncertainty, non-configuration, nonlinearity, and multiple-factor interactions are removed with the CephX functionality, as it allows for greater efficiency, productivity and in turn, higher quality of care delivery, without having to master complex imaging software tools.[5]

Visualization and Monitoring

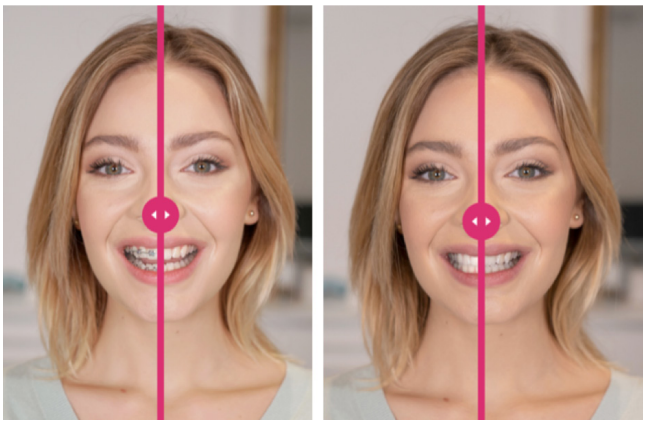


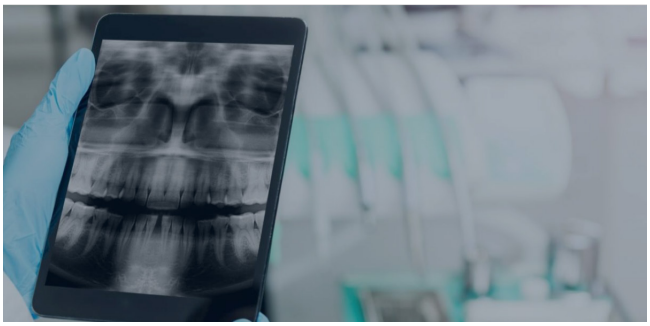
Figure 4 & 5. The patient can see what they would look like with different appliances and what their smile would look like post-treatment. Photo courtesy of Dental Monitoring.

Not only is AI able to analyze cephalometric images and CBCT scans for teeth and bone segmentation, AI is able to provide smile visualization and orthodontic monitoring. Dental Monitoring is a virtual platform that uses AI-powered solutions to offer patients an opportunity to envision their smile in different ways using Smile Simulations.[7] The Appliance Selection feature uses an assessment tool to envision orthodontics using traditional braces, ceramic braces, or aligners. Similarly, the Smile Prediction feature uses AI technology to transform a patient's smile; providing metaphorical results with pre-treatment and post-treatment outcomes.[7] In addition to Smile Simulations, DM uses neural networks to monitor orthodontic treatment progress. First, the neural networks are trained on dental pictures, depicting various orthodontic issues such as unseated aligners, dental attrition, debonded brackets, and poor oral hygiene.[6] The patient captures pictures of their ortho-dontic treatment progress. These pictures are stored, organized, and are accessible to the dental provider within the patient's electronic dental record.[7] Clearly, DM's application features are beneficial throughout the duration of orthodontic treatment, as it's features and functions can accurately detect issues and notify the patient accordingly.[6]

Figure 6. Patient providing scan using Photo monitoring light. Photo courtesy of Dental Monitoring.

Conclusions

Figure 7. Photo courtesy or Orca-AI.



The use of AI technology is advancing dentistry in ways that can increase the accuracy and diagnosis in all areas of the profession. Object identification and classification for teeth, tooth number detection, dental implants, and restorations have been demonstrated and are being offered within dentistry today; from use during routine dental appointments to implementation within other dental specialties.[11] Moreover, AI and machine learning techniques have proven to be successful in the design and fabrication of dental crowns and other restorations with the use of dental CAD software. Consequently, AI technology has gained the attention of the FDA, as the FDA already has high expectations for software used in the design and function of medical devices.[11] Significant challenges with the verification and validation of traditional software exists and the FDA is currently trying to solve the issue of clearance and compliance obligations for medical device manufacturers.[12] Conversely, it should be noted that recent regulatory updates were published in 2020, which allows a feasible regulatory pathway for dental (CADe) devices.[12] Nevertheless, AI has the ability to analyze data within the patient's electronic dental record. AI discovery and deep learning into dental and medical issues can provide the dental practitioner with valuable information to be used in real-time, allowing for a thorough examination and clinical decision support during treatment planning, whether remotely or within an in-office setting.[10] Ultimately, AI technology, techniques, and processes can enhance the quality of care in all dental settings.

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