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Original Research

Artificial Intelligence in Dentistry

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ABSTRACT:
Artificial intelligence, or intelligent systems, especially deep learning, are machines that can simulate human cognitive processes to carry out learning and problem-solving activities. This area of study focuses on building computational models that have intelligence and thought processes similar to those of the human brain, as well as algorithms that can learn from data and generate predictions.
Key words: Artificial Intelligence, deep learning, Human brain

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INTRODUCTION

Artificial intelligence (AI) has emerged throughout the world to mimic human intelligence and tackle certain challenges. AI can assist in the development of algorithms that can learn from information provided and make predictions. Machine learning creates algorithms based on data. One of the first type of AI algorithms to be developed was neural networks (NNs). Deep learning neural networks are structures with numerous levels and enormous layers, whereas shallow learning neural networks are simple network structures with only a few layers.[1]

Machine learning (ML)

Machine learning is a branch of computer science that builds algorithms guided by data.

Deep learning

Specific form of learning based on algorithms of neural networks. Representation learning

Representation learning

Is a subtype of ML in which the computer algorithm learns the features required to classify the provided data. This does not require a hand labelled data like ML.[2]

Artificial neural networks (ANNs)

This involves a networks of highly interconnected computer processors that has the ability to learn from past examples, analyse non-linear data, handle imprecise information and generalize enabling application of the model to independent data thus making it a very attractive analytical tool in the field of medicine.[3]

APPLICATIONS

Restorative Dentistry

Tooth decay is one of the most common oral diseases. Early diagnosis of tooth decay is important for the long-term preservation of natural teeth. In AI models performed in this area,tooth decay was detected on intraoral photographs and dental radiographs. In their study, Moutselos et al[4] reported that they detected occlusal tooth decay in the images obtained with the intraoral camera using the region-based convolutional neural network (CNN) model.Restorative dental treatment practice includes permanent and temporary filling materials, adhesive systems, prophylactic applications, high-speed rotating tools, and hand tools used in cavity preparation. Logicon Caries Detector™ program (Logicon Inc., USA) is designed to assist dentists in the detection and characterization of proximal caries.

Adequate chemo-mechanical preparation and effective filling of the root canal system in endodontics practice are closely related to the detailed knowledge of root canal morphology. Failure to treat all channels effectively leads to poor endodontic outcomes and reduces treatment success. In this sense, conical beam computed tomography (CBCT) has recently been used to evaluate root canal morphology. Conical beam computed tomography is an imaging method that offers noninvasive and3-dimensional reconstruction in endodontic applications and morphological analyses by clinicians. However, the use of CBCT poses a high risk due to the excessive exposure of patients to ionizing radiation.[5] As a newer method, AI studies have begun to be conducted on subjects such as the detection and location of canal orifices, the location of anatomical and radiological apical foramen, and the determination of the anatomical shape of the root canal in endodontics applications. Endodontic treatment aims to eliminate microorganisms and residues and to prepare the root canal system for obturation. The narrowest part of the canal is called apical stenosis, and ideally, the apical end of the preparation should be at this point. Radiographs are used to determine the end point of clinical procedures. Misinterpretation of radiographs leads to incorrect determination of working length. Determination of the working length in endodontics studies is one of the most important steps. Failure to determine the working length may cause insufficient or excessive root canal instrumentation.[6] Since the location of the radiological apical foramen may differ among clinicians, a second opinion can be obtained with the help of AI to contribute to the increasein the success of canal treatment. Studies have reported that artificial neural networks (ANNs) can be used to determine the radiographic location of the apical foramen and can help determine the working length in canal treatment. The software has been developed using augmented reality to perform real-time canal orifices detection and teeth classification through video images.[7]

Assessment of maxillary sinus pathologies

Maxillary sinusitis is characterized radiographically by mucosal thickening >4 mm, the air fluid level, and opacification. Paranasal sinus (PNS) views are used routinely for identification of maxillary sinusitis, and verification is made with CT scan, which is the preferred imaging modality for evaluating the air fluid level and sinus opacifications. These conventional radiographs create diagnostic difficulties due to overlapping of the maxillary sinus by facial bony structures, which may yield false-negative results. Deep learning programs increase the diagnostic ability of conventional radiographic views, thereby helping to avoid unnecessary referrals of patients for CT examinations, which have high radiation doses.[8]

Oral Pathology

Due to the high number of cysts and tumors in the maxillofacial region and their similar radiological appearance, it may be difficult to make a differential diagnosis of these lesions.26 Advanced imaging methods such as radiographs or CBCT and ultrasonography are frequently used to diagnose lesions in this region. It is widely preferred for imaging of maxillofacial regions since CBCT has advantages such as showing hard tissues well and less radiation than medical CT. Ultrasonography is generally used in dentistry to evaluate salivary gland diseases, foreign bodies in the soft tissues in the orofacial region, orofacial muscles, tongue lesions, and lymph nodes.[9] In order to make a more accurate radiological preliminary diagnosis, various studies have been conducted using systems developed with AI. In light of these studies, AI can give clues that can help clinicians in radiological diagnosis. Segmental analysis of cysts and tumors helps determine the location and size of the relevant structure.

Periodontology

Periodontal diseases are an important public health problem due to their high prevalence and may lead to the loss of teeth. Scaling and root planning form the basis of periodontal treatment. These procedures are usually performed with hand tools and aim to remove not only the debris on the root surface but also the dental tissue, albeit in small amounts.Krois et al[10] found that a convolutional neural network showed higher diagnostic performance, with an accuracy of 81%, than individual examiners, who showed an accuracy of 76%, in the radiographic detection of periodontal bone loss.

Maxillofacial Radiology

Due to the frequent use of pre-treatment imaging systems in dentistry and the high radiographic data, many suitable areas have formed for AI studies. Correct examination of radiograms depends on the ability of dentists to interpret images. Therefore, many AI studies can help the dentist in accurate and rapid diagnosis in radiological examinations. However, since the same standardization cannot always be achieved in radiological images and due to the complexities and errors in the images, AI cannot fully replace human intelligence in the interpretation of radiograms.[11]

Orthodontics

Accurate diagnosis is very important in orthodontic applications aiming to correct the irregularities in the teeth, the relationships of the jaws with each other, malocclusions, and the positions of the jaw bones on the facial skeleton. Malocclusions are common, and this is a serious public health problem in developed countries. Therefore, the causes and etiologies of malocclusions should be investigated. Many AI studies have been conducted in the field of

orthodontics. Artificial intelligence studies include various stages of orthodontic studies such as Landmark detection, skeletal classification, treatment planning, and help dentists. Thanks to these studies, orthodontists can evaluate patients more quickly and accurately before treatment.[12]

Pediatrics Dentistry

It is important that the diagnosis is accurate to determine the most appropriate treatment procedure in dentistry. Especially in pediatric dentistry, faster and more effective diagnoses enable patients to cooperate better and increase the success rate. Dentists commonly use periapical and PRs for diagnosis. Recently, AI sub-based systems have been developed to prevent dentists from overlooking dental problems and increase the accuracy of radiological diagnoses. In their study, Kılıç et a[13] evaluated the success of the DL method in the automatic detection and numbering of milk teeth and used 421 PRs of pediatric patients between the ages of 5 and 7 for this purpose.

Forensic dental imaging

Personal Identification **s**ystem using dental panoramic radiograph based on Meta Heuristic Algorithm reported to have 97.7% precision. Bewes et al[14] found that neural networks showed a 95% accuracy in distinguishing sex in 900 anthropological skulls reconstructed from CT scans. Intelligent systems could also improve the accuracy of age estimation methods, although very limited studies have yet investigated the application of neural networks for age determination.

ADVANTAGES

It is a powerful tool to identify patterns, predict behaviour or events, or categorize objects. Improvement of radiology departmental workflow through precision scheduling, identify patients most at risk of missing appointments, and empower individually tailored exam protocols. Machine learning directly with medical data can help in preventing the errors due to cognitive bias.[15-17]

CONCLUSION

Intelligent systems play a significant role in Dentistry in making diagnostic recommendations. They have been found to be effective in every field in dentistry as a way to obtain a quick diagnosis and treatment plan for complex problems unresolved by the human brain.

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