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Review Article

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ARTIFICIAL INTELLIGENCE: BEGINNING OF A NEW ERA IN DENTISTRY

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ABSTRACT

The term "artificial intelligence" (AI) refers to the idea of machines being capable of performing human tasks. A subdomain of AI is machine learning (ML), which "learns" intrinsic statistical patterns in data to eventually cast predictions on unseen data. With recent progress in digitized data acquisition, machine learning and computing infrastructure, AI applications are expanding into areas that were previously thought to be reserved for human experts. When applied to medicine and dentistry, AI has tremendous potential to improve patient care and revolutionize the health care field. In dentistry, AI is being investigated for a variety of purposes, specifically identification of normal and abnormal structures, diagnosis of diseases and prediction of treatment outcomes. This review describes some current and future applications of AI in dentistry.

KEYWORDS: Artificial intelligence, machine learning, digital, data, dentistry.

INTRODUCTION

The term "artificial intelligence" (AI) was coined in the 1950s and refers to the idea of building machines that are capable of performing tasks that are normally performed by humans. Machine learning (ML) is a subfield of AI, in which algorithms are applied to learn the intrinsic statistical patterns and structures in data, which allows for predictions of unseen data. A popular type of ML model are neural networks (NNs), which outperform more classical ML algorithms in particular on complex data structures such as imagery or language.[1]

Deep learning (DL) is a sub-branch of ML wherein systems attempt to learn, not only a pattern, but also a hierarchy of composable patterns that build on each other.

An extremely popular class of DL algorithms is the artificial neural network (ANN), a structure composed of many small communicating units called neurons organized in layers. A neural network is composed of an input layer, an output layer and hidden layers in between.[2,3] It is possible to have 1 or a few hidden layers (shallow neural network) or multiple/many hidden layers (deep neural network, DNN)

AI application in Health care

There has been a significant uptake of these technologies in medicine, too, so far mainly in the field of computer vision. A number of drivers for this uptake have been identified (Naylor 2018):

1) Diagnostic imaging is central in many healthcare fields, with AI being especially suitable to overcome the variability in subjective individual examination and to increase the effectiveness of care while lowering costs by eliminating routine tasks.
2) Digital health data are ubiquitously collected, and while so far these data are rather heterogeneous, organizations are increasingly striving to provide cleaned, curated, and structured data.[4]
3) AI allows to integrate different and heterogeneous data domains, for example, medical/dental history, sociodemographic and clinical data, imagery data, biomolecular data, social network data, etc., thereby making the best use of these multi-level data and allowing to grasp their interaction.
4) AI facilitates research and discovery, by adding in silico experimentation options to conventional research hierarchies, complementing other research levels and existing modeling strategies.
5) AI also promises to make healthcare more participatory, especially if patients provide their data actively, for example using wearables, etc. Patients will be empowered by self-monitoring and self-management.
6) Using these continuously collected data may also overcome the disadvantages of "on-off-medicine", where patients are seen only for a few minutes, while most health conditions are usually acquired over years, and come and go in (oftentimes escalating) intervals (e.g., periodontal disease). Continuous non-invasive monitoring of health and behavior will enable a much deeper, individual understanding of the drivers and processes underlying health and disease.[5]

7) Diagnostic and treatment costs may be decreased, thereby relieving healthcare systems burdened by an ageing society with an increasingly high numbers of complex, chronically ill cases.

AI application in dentistry

In medicine and dentistry, one of the most commonly used subclasses of ANN is the convolutional neural network (CNN) (**Figure 1c**). A CNN uses a special neuron connection architecture and the mathematical operation, convolution, to process digital signals such as sound, image and video. CNNs use a sliding window to scan a small neighbourhood of inputs at a time, from left to right and top to bottom, to analyze a wider image or signal. They are extremely well adapted to the task of image classification and are the most-used algorithm for image recognition.[2]

Dental Radiology

CNNs have shown promising ability to detect and identify anatomical structures. CNNs have also been used for the detection and diagnosis of dental caries.[6] In 3000 periapical radiographs of posterior teeth, a deep CNN algorithm was able to detect carious lesions with an accuracy of 75.5–93.3% and a sensitivity of 74.5–97.1%. This is a considerable improvement over diagnosis by clinicians using radiographs alone, with sensitivity varying from 19% to 94%.[7] Deep CNNs have great potential for improving the sensitivity of dental caries diagnosis and this, combined with their speed, makes them one of the most efficient tools used in this domain.

Orthodontics

ANNs have immense potential to aid in the clinical decision-making process. In orthodontic treatments, it is essential to plan treatments carefully to achieve predictable outcomes for patients. However, it is not uncommon to see teeth extractions included in the orthodontic treatment plan. An ANN was used to help determine the need for tooth extraction before orthodontic therapy in patients with malocclusion.[8]

Periodontics

According to the 1999 American Academy of Periodontology classification of periodontal disease, clinical types of periodontitis are recognized: aggressive (AgP) and chronic (CP) forms.[9] Because of the complex pathogenesis of the disease, no single clinical, microbiological, histopathological or genetic test or combination of them can discriminate AgP from CP patients.[10] Papantanopoulos and colleagues used an ANN to distinguish between AgP and CP in patients by using immunologic parameters, such as leukocytes, interleukins and IgG antibody titers.

Endodontics

Although mandibular molars tend to have similar root canal configurations, several atypical variations may occur.[11] To minimize treatment failures related to morphological differences and to optimize the clinical outcomes of endodontic therapy, cone-beam computed tomography (CBCT) has become the gold standard. However, because of its higher dose of radiation compared with conventional radiographs,[12] CBCT is not used systematically. To overcome such challenges, AI has been introduced to classify the given data using a CNN[13] to determine whether the distal root of the first mandibular molar has 1 or more extra canals. Radiographs of 760 mandibular first molars taken with dental CBCT were analyzed.

Oral Pathology

Detection and diagnosis of oral lesions is of crucial importance in dental practices because early detection significantly improves prognosis. As some oral lesions can be precancerous or cancerous in nature, it is important to make an accurate diagnosis and prescribe appropriate treatment of the patient. CNN has been shown to be a promising aid throughout the process of diagnosis of head and neck cancer lesions. With specificity and accuracy at 78–81.8% and 80–83.3%, respectively (compared with those of specialists, which were 83.2% and 82.9% respectively), CNN shows great potential for detecting tumor tissues in tissue samples or on radiographs.[14,15]

One study used a CNN algorithm to distinguish between 2 important maxillary tumors with similar radiologic appearance but different clinical properties: ameloblastomas and keratocystic odontogenic tumours.[15]

CONCLUSIONS

Although multiple studies have shown potential applications of AI in dentistry, these systems are far from being able to replace dental professionals. Rather, the use of AI should be viewed as a complementary asset, to assist dentists and specialists. It is crucial to ensure that AI is integrated in a safe and controlled manner to assure that humans retain the ability to direct treatment and make informed decisions in dentistry.

REFERENCES

1. Yu KH, Beam AL, Kohane IS. Artificial intelligence in healthcare. Nat Biomed Eng., 2018; 2(10): 719-31.
2. Nielsen MA. Neural networks and deep learning. Determination Press, 2015.
3. Russell SJ, Norvig P. Artificial intelligence: a modern approach. 3rd ed. Hoboken, N.J.: Prentice Hall, 2010.
4. Naylor CD. On the prospects for a (deep) learning health care system. JAMA, 2018; 320(11): 1099–1100.
5. Topol E. Deep medicine: how artificial intelligence can make healthcare human again. New York: Basic Books, 2019.
6. Lee JH, Kim DH, Jeong SN, Choi SH. Detection and diagnosis of dental caries using a deep learning-

based convolutional neural network algorithm. J Dent., 2018; 77: 106-11.
7. Bader JD, Shugars DA, Bonito AJ. Systematic reviews of selected dental caries diagnostic and management methods. J Dent Educ, 2001; 65(10): 960-8.
8. Xie X, Wang L, Wang A. Artificial neural network modeling for deciding if extractions are necessary prior to orthodontic treatment. Angle Orthod, 2010; 80(2): 262-6.
9. Armitage GC. Development of a classification system for periodontal diseases and conditions. Ann Periodontol, 1999; 4(1): 1-6.
10. Armitage GC. Learned and unlearned concepts in periodontal diagnostics: a 50-year perspective. Periodontol 2000, 2013; 62(1): 20-36.
11. Hiraiwa T, Ariji Y, Fukuda M, Kise Y, Nakata K, Katsumata A, et al. A deep-learning artificial intelligence system for assessment of root morphology of the mandibular first molar on panoramic radiography. Dentomaxillofac Radiol, 2019; 48(3): 20180218.
12. Zhang X, Xiong S, Ma Y, Han T, Chen X, Wan F, et al. A cone-beam computed tomographic study on mandibular first molars in a Chinese subpopulation. PLoS One, 2015; 10(8): e0134919.
13. Xue Y, Zhang R, Deng Y, Chen K, Jiang T. A preliminary examination of the diagnostic value of deep learning in hip osteoarthritis. PLoS One., 2017; 12(6): e0178992
14. Halicek M, Lu G, Little JV, Wang X, Patel M, Griffith CC, et al. Deep convolutional neural networks for classifying head and neck cancer using hyperspectral imaging. J Biomed Opt., 2017; 22(6): 60503.
15. Poedjiastoeti W, Suebnukarn S. Application of convolutional neural network in the diagnosis of jaw tumors. Healthc Inform Res., 2018; 24(3): 236-41.